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EDITORIAL

The changing social, technical and regulatory environment in which British Telecom operates is continuing to provide the stimulus and challenge for engineers. This is well underlined by the wide range of articles in this edition of the *Journal*, ranging from the problems with groundwater to the brave new world of the digital derived services intelligent network.

The past decade has seen significant developments in technology and in some respects the pace of change is accelerating. The challenge is to use the emerging technology for the benefit of customers and the Company. The key is customer first.

Customer needs have to be well understood for both existing and new services. This theme has been well underlined in articles in previous issues of the *Journal*. The past year has seen significant improvements in the quality of service BT provides to its customers. The article on page 128 describes another important area aimed at providing a world class service for customers, the Front Office. For many of BT's customers their first contact with BT is the Front Office where they will expect timely, courteous and efficient response to their needs. The article by Neil Runciman outlines just how BT is addressing this area. Another area of some importance to the nearly 5 million London customers is the code change planned for 6 May 1990. It is vital for this essential change to be widely understood and implemented with great care. The article 'London Code Change' brings out the detailed planning and actions necessary to ensure an efficient change.

Last, as first, we have the customers and their need for excellent services. In the next edition of the *Journal*, Jon Chidley, General Manager, Marketing Strategy Unit, BTUK, will be providing an insight into how BT finds out what customers require; how their needs may be expressed numerically; and then be related to practical planning and operational objectives. This article will reinforce the message to all BT people that 'customers come first'.

A Common Integrated Database—The Key to Improved Customer Service

C. N. RUNCIMAN†

This article discusses the implementation of British Telecom's Customer Service Systems (CSS) and Front Office working. The article is based on the author's presentation at the 28th European Telecommunications Congress held in Lisbon, Portugal, from 3–9 September this year.

RECOGNISING THE NEED TO IMPROVE CUSTOMER SERVICE

In the early-1980s, the increasing trend towards liberalisation focused the attention of the British Telecom Management Board on how the organisation needed to evolve to meet the competition of the late-1980s and early-1990s. The organisation at that time owed much to British Telecom's past, especially its status as a monopoly telecommunications supplier, which began to look increasingly archaic, as did the shortcomings of customer service computer systems which were:

- They did not permit a quick response to customers.
- They were mainly batch processes and carried 'out of date' information, often days behind events.
- They replicated earlier manual methods.
- They were designed with headquarters' needs in mind, not the operational needs of the business.
- The data was split over many systems using different hardware.

McKinsey, Management Consultants, were contracted in 1983 to examine British Telecom and make recommendations on the changes needed. McKinsey identified five major areas needing change, three of which are relevant:

- British Telecom was then inward and upward looking.
- Key tasks (for example order processing) were operationally fragmented.
- Local managers had limited scope to influence performance.

DEVELOPMENT OF THE CONCEPT

McKinsey had recommended new customer service systems and an integrated computer database which would provide economic and effective storage of information, plus greater responsiveness to BT's customers. The three functions of BT that this mainly involves are sales processing, billing and fault taking/processing. These three areas use much common information:

Name
Address
Telephone number
Existing products/services, etc.

Various alternatives were considered to improve customer support:

(*a*) connect together existing systems,
(*b*) obtain proprietary packages, and
(*c*) start afresh with a new development.

As no suitable proprietary system was available, a decision was made to develop a new system as this offered greater flexibility to meet business needs now and in the future. The full range of facilities could be incorporated and, most importantly, customer service could be improved.

From late-1983–84, work progressed on specifying the electronic integrated database required with the prime objectives of:

- improved customer service,
- increased efficiency and cost effectiveness, and
- better financial and management information.

The major design philosophies were as follows:

(*a*) A special user group was established made up of experts in the different functions. They mainly came from field operations in the Districts and knew what was needed to improve customer service.

(*b*) Facilities were designed to meet the business needs, not existing practices as had happened with earlier information systems.

(*c*) An integrated database was developed:

(*i*) to ensure the integrity of data used by many different operations,

(*ii*) to increase the scope for the changing needs of the business,

(*iii*) to make systems more efficient and responsive to management for information, and

(*iv*) to achieve more efficient development.

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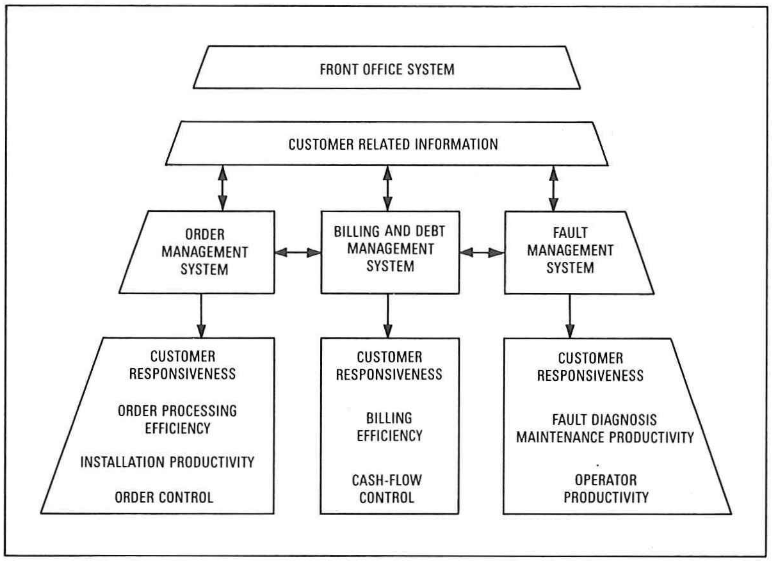
† Field Operational Support, British Telecom UK

The CSS approach has been to bring all major customer-facing systems into one integrated database. In effect, it would be capable of supporting receptionists whether they receive a billing enquiry, an order or a fault report from a customer. The same receptionist would be able to deal and respond to such enquiries from one terminal and know that the very latest information on the topic would be to hand.

The implemented system supports the order, bill and fault processes, giving up-to-the-minute activity information. It allows completion of activity reporting, from any terminal within the District, promptly and simultaneously to all other users of the system.

The interfaces to achieve this are shown in Figure 1.

Figure 1
Integration of customer-facing functions



NATIONAL IMPLEMENTATION OF CSS

CSS was implemented in the first District in 1986. There followed a period of intensive software modification and improvement, as this system of unprecedented size and scope was tested with live data. In the autumn of 1986, two further Districts implemented CSS. There was a further period of consolidation in 1987 when functionality and reliability of the system increased significantly. In 1988, CSS implementation was underway, and by the end of 1988, over a third of BT's customer records had been loaded onto CSS. Initial implementation of CSS is planned for completion by the end of November 1989 with the implementation of Western London. Development of the facilities of the present functions continues; for example, integration of the line test systems, an operations and maintenance centre (OMC) interface and an integrated access to a credit vetting database.

The CSS terminal population is of the order of 50 000 visual display units. There are some 27 District computer centres interconnected via MegaStream links and connected to an extra site equipped to act as a fall-back in case facilities in a District are lost due to a major disaster, such as flooding. In the event of such a major disaster, terminal traffic can be re-routed from any one District to this site.

The scale of the system can be demonstrated by highlighting some facts about a typical CSS District database:

3 million COBOL statements
1000 on-line programs
2000 screen options
140 million database records
800 database record types
50 Gbyte disc storage
500 000 transactions per day
2–3 second response times

DEVELOPMENT OF FRONT OFFICE

Front Office is a way of organising a District to improve customer service. The readily-available customer-related information on CSS enables a Front Office receptionist to:

(*a*) sell,
(*b*) inform the customer of the progress of an order,
(*c*) take and amend directory entries,
(*d*) answer billing queries,
(*e*) take fault reports and diagnose faults (with line test systems), and
(*f*) inform the customer of the progress of a repair,

all from one terminal.

By the autumn of 1984, the Front Office concept was being evaluated by BT Headquarters with Districts, with a need to resolve three interdependent issues:

(*a*) Could selected District staff develop the skills to handle sales, billing queries and fault reporting in a confident, responsive and efficient manner?

(*b*) Could Districts implement easy-to-use on-line computer and communications systems needed to handle these functions?

(*c*) Could new District management controls be introduced so that Front Office staff, and other staff supporting them, would have the authority and motivation to resolve problems, make commitments and ensure results?

After some preliminary work, it emerged that the only clear way to resolve these issues was to trial Front Office on more than one site and evaluate the results. Two trial Front Offices were opened in different Districts.

These Districts evolved their Front Offices at their own pace and direction, but, by early-1988, both had achieved full-size Front Offices. Their experience proved that Front Office:

(*a*) can handle over 90% of customer calls within the defined scope (sales, order processing, billing queries, fault-reception\diagnosis and general enquiries);

(*b*) can be staffed by the existing clerical officer grade;

(*c*) can use an on-line computer (CSS) and a communications system (automatic call distributor (ACD)) efficiently and effectively; and

(*d*) can be developed to provide customer-orientated District management controls, supplemented by modified customer perception measurements and a quality management system. Additionally, with a further refinement of procedures, there was an opportunity to reduce costs through economies of scale, and the breakdown of functional barriers, while improving the contact with the customer.

The BTUK Management Board approved further development work in November 1988, and an intense development phase lasted until June 1989. This phase produced:

(*a*) Receptionist and management procedures for sales, billing queries and fault reception document to BS 5750/ISO 9000. The procedures were reviewed on an interactive basis with seven Districts and with eight contributing HQ departments.

(*b*) A fully developed modular training package of 29 days with in-built assessment.

(*c*) A PERT chart for Districts to use as a skeleton for their Front Office implementation planning.

(*d*) Clarification of Front Office with the BT vision of quality of service for 1995.

(*e*) Development of the interface with a number of HQ initiatives:

(*i*) credit referencing,

(*ii*) customer service guarantee scheme,

(*iii*) debt management system, and

(*iv*) extending the interface with line test systems.

Development will continue for Front Office and is unlikely to halt as customer needs change and evolve. The procedures have been designed to evolve in a progressive manner through the periodic reviews which are built into the quality management system.

A QUALITY MANAGEMENT SYSTEM TO ISO 9000 IN FRONT OFFICE

Presently, all Districts have quality management systems to ISO 9000 for fault reception\repair, and more than one District for sales\order processing. With all the customer-facing functions moving toward quality management systems, the national Front Office procedures were written to meet the standard for a ISO 9000 quality management system. Such a system has implications on the HQ groups with responsibilities for Front Office and the Districts that implement Front Office.

The effect on HQ groups is:

(*a*) to clarify responsibilities and tasks,

(*b*) to impose a discipline in regard to instructions to Districts,

(*c*) to provide a vehicle for customer-facing initiatives, and

(*d*) to provide formalised feedback of customer-facing initiatives from Districts to HQ.

HQ initiatives will be introduced into the Front Office procedures at the six-monthly review, although urgently-required changes can be exceptionally accommodated more quickly.

The effect on Districts should be:

(*a*) to clarify service level agreements between the customer-facing staff and order\fault\bill processors (availability, speed of response and quality of response);

(*b*) to clarify tasks as a consequence of the service level agreement;

(*c*) to re-focus the District on external measures of performance, rather than internal measures; and

(*d*) to improve customer service.

The Districts are obliged to carry out quality checks to ensure that the Front Office receptionist is following the procedures (the customer communication code is being followed, accurate diagnosis of the customer's problem is being recorded and the correct commitments are being made).

Customer perception of the Front Office will be measured by telephoning a sample of customers on the evening of contact; the customer satisfaction levels are recorded and tracked.

NATIONAL IMPLEMENTATION OF FRONT OFFICE

There are now three Districts trialling Front Office. Implementation throughout the UK will take place over the next two years. The main benefits of Front Office implementation will be improvements to customer service:

- improved customer perception,
- single-point contact for customers,
- improved internal efficiencies,
- the ending of internal anomalies,
- a vehicle for other changes,
- reduced correspondence levels,
- professional customer service, and
- targeted customer perception measures.

Biography

Neil Runciman joined BT in Manchester Area as an engineering apprentice in 1966. After a period in transmission, he obtained an ONC in light electrical engineering and a City and Guilds Certificate in Telecommunications. At this time, he was commissioning private wires and Datel modems in customer premises and setting up the lines for outside television broadcasts. Since 1986, he has worked on CSS, first as a District implementation manager and, after promotion, in an HQ role advising Districts and developing Front Office.

DIDUMS—A Solution to Exhausted MDFs

A. DIBBEN†

The rapid growth in telecommunications in recent years has led to considerable problems with the exhaustion of main distribution frames (MDFs) as they become ever larger and more unwieldy. In an effort to overcome these difficulties without resorting to the trouble and expense of complete new frames, particularly during exchange transfers, Thameswey District has been using an overlay system whereby the permanent wiring is terminated on a temporary overlay frame which is subsequently incorporated into the MDF. The trial has been addressing a key problem and this particular solution will be considered along with others by BTUK Headquarters along with other solutions.

INTRODUCTION

British Telecom's past, and present, modernisation programs have touched almost every aspect of exchange equipment with the exception of the main distriution frame (MDF). Only now are a few of the modular single-sided frames creeping into the system, mainly on a trial basis to see if they really do offer any significant operational advantages over the old traditional type of MDF. The fact that the MDF has remained basically the same for so many years is a credit to its design and versatility. It has been able to accommodate all the new systems that have been connected to it over the years, using different kinds of blocks with increasing capacity, and still with few exceptions remained manageable. Unfortunately, time catches up with everything and with the tremendous growth in demand for telecommunications services over the years, space on MDFs became exhausted. In the past, MDFs were simply extended, but they are now reaching such lengths that they have become economically and physically unmanageable and, in some cases, there is no available space to accommodate the next replacement exchange unit.

POSSIBLE SOLUTIONS

One answer to this problem would be to install a new MDF, but this would also mean having to move all the external plant terminations onto it. This is a very costly and time consuming operation which provides no real benefit to the Business. Another solution would be to compress, where possible, the existing equipment onto 100-pair blocks and re-jumper to make space, but again this is very costly and provides no benefits.

OVERLAY SYSTEM

An alternative is to use an overlay system on the existing frame. Such an overlay system, known as *DIDUMS*, has been used in the Thameswey District to facilitate exchange transfers. The system consists of an overlay framework, of the same design as the frame being covered (for example, MK1 or MK2 frame), which can be positioned anywhere along the MDF (see Figure 1). This frame is used to terminate the new

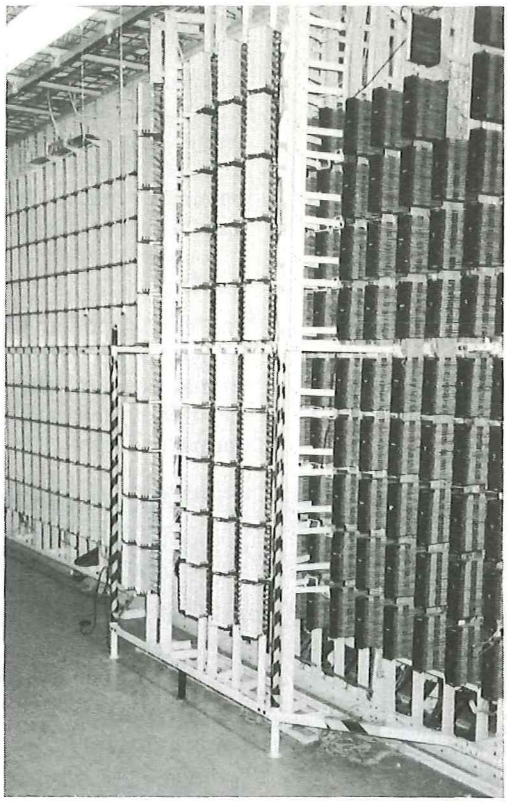


Figure 1—Overlay unit in front of MK2 frame

exchange equipment. Because the terminal blocks on the overlay frame are physically incorporated into the existing MDF after the exchange transfer, this overlay frame must be positioned over terminations that will be recovered after the transfer.

† Thameswey District, British Telecom UK

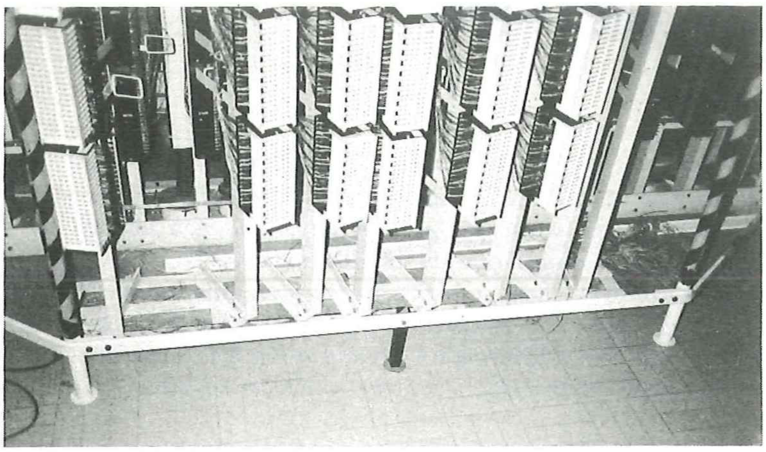


Figure 2
Hinge arrangement on MK2 frame

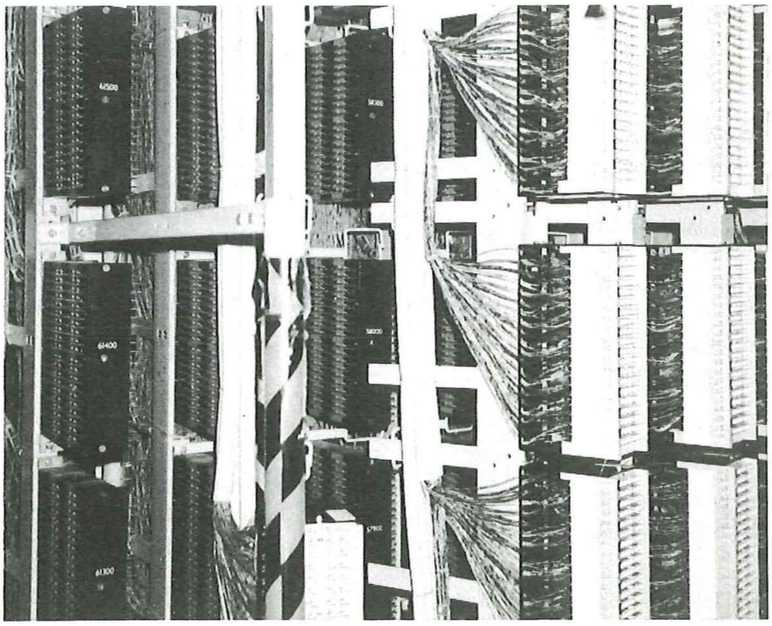
The overlay units are hinged to allow access to the equipment that has been covered. To allow the subsequent removal of the existing verticals on a MK2 frame, the hoop at the top and bottom is removed and the earth bar moved down to floor level before positioning the overlay units. The units are placed just far enough in front of the existing frame to allow the units to hinge without touching any change-over wedges that have to be fitted (see Figure 2).

Once the overlay unit is in position, the new blocks are cabled and jumpered in the usual manner. The new blocks are both cabled and jumpered while fixed to the overlay framework, the units being hinged to allow access to the equipment that has been covered.

Cabling

The cabling for a MK2 (rack type) frame is brought down above the existing frame in its normal position, and then taken forward onto the overlay unit and tied to the cable bars as normal and terminated (see Figure 3). This unit

Figure 3
Cabling on DIDUMS for MK2 Frame



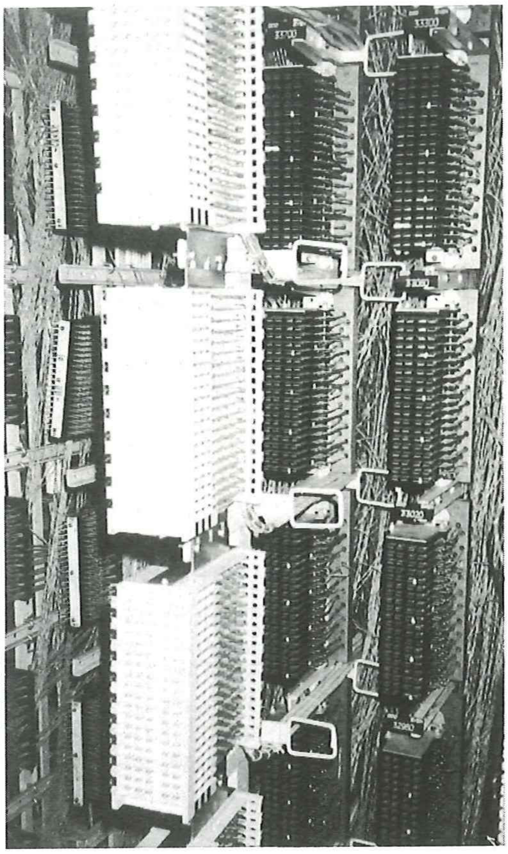


Figure 4—Hinged verticals on MK1 frame opened to show cabling arrangement and new jumper rings

will eventually replace the existing vertical on the MDF.

The cabling for a MK1 (T1101) frame is different as the MDF vertical is not replaced by the overlay unit, but has the new blocks moved back onto it after transfer. The cabling is brought down the existing vertical and taken forward when it reaches the relevant horizontal position (see Figure 4). To prevent damage to this cabling when hinging the units, they are only allowed to hinge to the right.

Two split jumper rings are fitted, one behind the existing block, and one on the overlay unit in such a position that the new jumpers can be channelled through the gap between the existing blocks, so that they do not fan across the face of the existing wiring obscuring it from view. When terminated on the new block, the jumpers have a length of slack equivalent to the distance from the old blocks to the new introduced into them so no extra slack is required when running the jumpers.

Frame Transfer

With the MK2 frame, after the exchange transfer, the old vertical, blocks and wiring, are removed from the MDF along with the temporary jumper rings. These are then totally replaced by moving the overlay unit into the vacant space. Finally, the hoops and earth bar previously removed are replaced.

With the MK1 frame, the old blocks and wiring are removed and replaced by the ones from the overlay frame. The overlay framework is then re-usable.

It is desirable when using this system to provide temporary guard rails around the units, and to either move back the existing travelling ladder or provide a temporary one to give a safe working platform. If existing multiple appearances have been covered, which is likely, then the Number Allocation Duty should be asked to close that particular range of the exchange multiple, if possible, for the duration of the transfer. This will reduce the numbers of staff who are likely to need to work on that particular part of the frame that has been covered by the overlay ironwork.

CONCLUSION

The overlay method offers a low-cost and effective answer to the problem of MDF exhaustion. It has the advantage of flexibility in provision and only needs to be put into position when the cabling operation is about to commence.

It should be recognised that the use of DIDUMS raises many site-specific situations which need to be addressed prior to use; for example, safety, lighting, frame service co-operation etc.

Thameswey District is also using the DIDUMS overlay units in a trial on the zoning of long MDFs by spreading the new equipment along the length of the MDF, and forming it into zones. This gives the advantage of short jumper runs within each zone, and a reduction in the unit cost of providing a customer's line.

The possible impact on customer service of the jumper congestion and disturbance during conversion, and the overall cost of the process combined with subsequent running costs, need to be assessed prior to BTUK HQ determining whether DIDUMS should become policy.

Biography

Tony Dibben joined the then British Post Office in 1962 as a direct entrant and became a T2B Labourer on construction duties. He worked on many systems ranging from manual exchanges, Strowger, TXE2 and crossbar group switching centres before being promoted to a Level 1 on internal planning and works.

London Code Change

U. BANERJEE, K. RABINDRAKUMAR, and B. J. SZCZECH†

This article describes the background to the London code change and the method by which it will be implemented.

INTRODUCTION

On 25 April 1989, British Telecom announced the London code change, which will take place at one minute past midnight on Sunday 6 May 1990. At that time, the 01 dialling code for London will be withdrawn, to be replaced by two new codes, 071 for inner London and 081 for outer London.

Customers' numbers will not be affected by the code change. The only change which customers will notice is that, when dialling from outside the two new areas, they will need to dial the new code 071 or 081 as appropriate. Similarly, customers will need to use the new code when dialling between the two new areas. A customer in the 071 area will, therefore, need to dial the full national number including the 081 code for a customer in the 081 area. The new code will not be required when dialling within either of the new areas.

This article describes the process by which this scheme was chosen and then discusses the work which will be required to bring the new scheme into operation. This can be divided into four main areas: network changes, computer support system changes, changes to network-related products and services, and customer communication activities.

NEED FOR AND SELECTION OF SCHEME

Evolution of the London Numbering Scheme

In 1927, the first London automatic exchange opened at Holborn. Telephone dials were marked with letters as well as numbers, and exchanges were given three-letter names; for example, HOL for Holborn, WHI for Whitehall and HAM for Hampstead. Customers would dial the three-letter exchange name followed by a four-digit number. Some London place names had the same first three letters, and so some imaginative names were adopted. For example, Hammersmith lost out to Hampstead and became RIV for 'Riverside'.

The use of names for exchanges was a valuable aid to memory. However this system suffered from two major drawbacks. Firstly, there is no agreed international standard for the positioning of letters on a telephone dial, and therefore directly dialled international calls would have been very difficult. Secondly, there are only a limited number of easily remembered combinations of letters.

Even after some highly creative names such as VAL for Valentine and VIG for Vigilant had been introduced, by 1967, when 253 codes were in use, new names were becoming difficult to find, and exchange names were replaced with all-figure number (AFN) codes.

Capacity of the Existing London Numbering Scheme

From 1967, therefore, London numbers have been in the format 01 – AFN XXXX, where 01 – is the code for London, the AFN code denotes the exchange, and XXXX is the customer number. Customers dial AFN XXXX for calls within the 01 area, and the full national number for calls from elsewhere in the country.

At first glance, a numbering scheme with the format 01 – ABC XXXX should provide 10 million possible numbers, and therefore it is difficult to see how the scheme is nearing exhaustion. Unfortunately, the practical capacity of the scheme is considerably less than this. Firstly, the AFN code cannot begin with 0, as this is used to indicate a trunk call. Neither can it begin with 1, as this is used to indicate service codes, such as 100 for operator assistance and 142 or 192 for directory enquiries. This reduces the capacity to 8 million numbers. Capacity is further reduced because spare numbers in the block of 10 000 associated with an AFN must, in general, be used within that exchange area. In addition, the current London routing plan requires the AFNs to be allocated to specific sectors. For example, 68X is assigned to the South sector and 85X to the South East sector. Until the network is fully digital, the restrictions on allocation of AFNs in decades limits the flexibility in the use of spare AFNs in central London where demand is greatest. In addition, a certain proportion of numbers are kept ste-

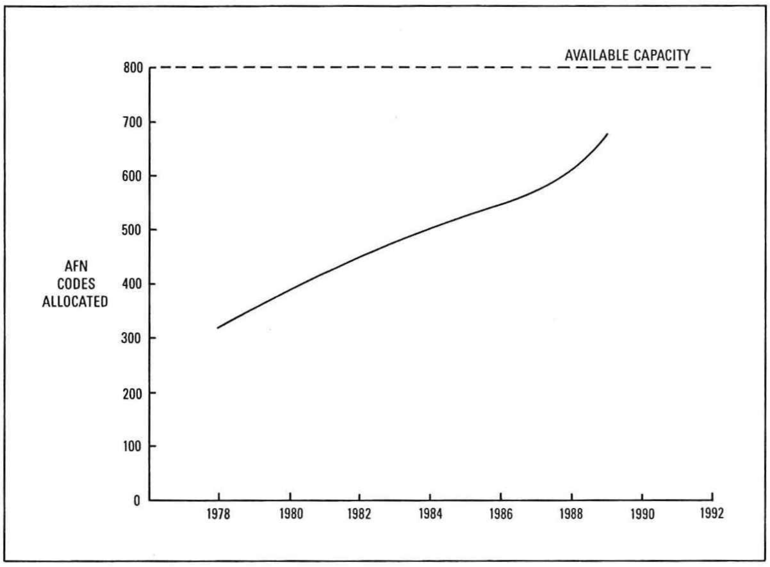
† London Network Operations District, British Telecom UK

rilised at any one time; for example, because they are generally not reallocated for one year after a customer ceases service, to reduce instances of called in error. Because of these restrictions, the capacity is reduced to approximately 60% of the 8 million possible numbers, to 5 million numbers. This 60% utilisation compares favourably with other major cities of the world and very favourably with remote rural areas, where the utilisation can be as low as 2%.

This 5 million capacity has been severely strained in recent years by the explosive growth in demand for new telephones, the demand for new services such as direct dialling in (DDI) to PBX extensions, where each extension has its own number within the national numbering scheme, and the wider use of facsimile machines. Also, the available AFNs are required to be shared with Mercury Communications Ltd.

Figure 1 shows the growth in the use of the 800 available exchange codes. 40 new codes were introduced during 1988 alone. The graph illustrates clearly the strain on the existing scheme.

Figure 1
Demand for AFN Codes in London



International Examples

London is not unique in its need for number expansion. In France, the numbering plan introduced in 1955 had led to saturation from 1974 onwards in some areas, and this had been solved by splitting the saturated areas into two or more new areas. By 1985, the Ile-de-France and Alpes-Maritimes areas had become saturated and a more radical solution was required. In that year, there were 23 million subscribers, compared with 2 million in 1955. Under the new French numbering plan, which was introduced on 25 October 1985, France is divided into two numbering zones, l'Ile-de-France, which covers Paris and the immediately surrounding area, and the rest of France, known as *La Province*[1]. Subscribers dial an 8-digit number within each of the zones and add a prefix for calls made between the two zones.

In the United States, some of the numbering plan area (NPA) codes have become saturated and have been replaced with two new codes. The most well known of these is in New York, where the new code 718 was introduced on 1 September 1984, to supplement the existing 212 code. Between that date and the end of the year, a *permissive dialling* period was provided, and the new codes became compulsory on 1 January 1985. The 212 code now covers only Manhattan and the Bronx. Brooklyn, Queens and Staten Island were allocated the new 718 code. Code splits have also been introduced in recent years in the Los Angeles, San Diego, Houston and eastern Massachusetts areas.

Consultation on the Choice of Scheme

As soon as it became clear that the London scheme would exhaust, BT developed a range of proposals and put these to the Office of Telecommunications (OFTEL). The proposals were discussed fully by the Telecommunications Numbering and Addressing Board Limited (TNAB), which is the independent consultative body established by OFTEL for this purpose. This body consists of PTOs including BT and Mercury Communications Limited, as well as major user groups.

TNAB unanimously endorsed the 071/081 scheme as being the best of the options presented to it. The proposal was then passed to the Director General of OFTEL, who subsequently confirmed that he was satisfied that this proposal adequately met the criteria set out in Condition 34.5 of the BT Licence and is sufficiently compatible with the numbering plans of the other PTOs.

Alternatives Considered

Two broad options could have been adopted to expand London numbering capacity. Either the 01 code could be retained and customers' numbers expanded from 7 digits to 8 digits, or the existing 7-digit number length could be retained and two or more new codes introduced.

The option of extending London number length from 7 to 8 digits was given serious consideration, but was, however, rejected since it would be difficult to provide recorded announcements to assist customers who misdial immediately after the number change had been introduced. This is because all major combinations of digits are already in use within the London director area, and therefore exchange equipment would be unable to discriminate misdialled calls if an overnight change was made. Helpful recorded announcements could only be introduced in such a scheme if number lengths

were extended in a phased manner. For example, in phase one, all existing 2XX XXXX numbers would be extended to 22XX XXXX and then at some later date all YXX XXXX numbers would be extended to 2YXX XXXX. (In this example, X = digits 0 to 9 and Y = digits 3 to 9.)

Thus, it was considered better to retain the existing number length and to replace the 01 code with two codes. Two decisions were needed here: firstly, where should be the boundary between the new code areas, and secondly what the new codes should be.

Several options for the position of the boundary were considered. The most obvious of these would be the River Thames. This would have the advantage that many London residents have a reasonable understanding of London's geography and therefore would know if a called number lies in the 'North' or 'South' areas. Unfortunately, with the existing network structure, a split along the river would provide most spare capacity south of the river, and not in the major growth areas, which are north of the river and particularly in the City and Docklands. The split which best provides spare capacity where it is needed is the inner and outer split which has been adopted (Figure 2). The boundary between the 071 and 081 areas lies approximately along a 4 mile radius of Charing Cross and extends eastwards into the growth area of the London Docklands. It follows existing exchange area boundaries.

When considering the choice of codes to be used for the new areas, the codes 01 (the existing code), and 071 and 081 were available. All other 0X1 codes are already in use for other major cities. The maximum length of a code for London would be 2 digits (plus the leading 0), because London numbers are 7 digits in length, to comply with the current UK maximum number length of 9 significant digits†.

If the code 01 was to be retained for one of the code areas, it would be impossible to use the numbers released in the other code area for a considerable period of time. To do otherwise would cause confusion for customers. For example, at the date of the code change, if Company X was located in the area which would be given the 081 code, its telephone number 01−688 1234 would become invalid and become 081−688 1234. So customers dialling 01−688 1234 would receive a recorded announcement asking them to redial using 081 instead of 01. At some early point in the future, because of the lack of capacity (refer again to

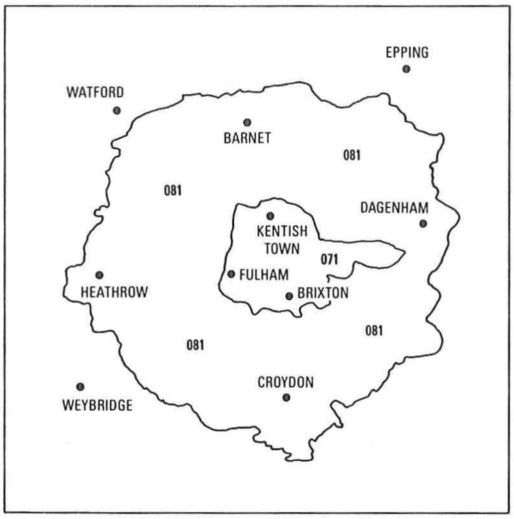


Figure 2
The new London code areas

Figure 1), the 01−688 1234 telephone number would need to be re-introduced, for Company Y on a new exchange in the opposite code area. So customers dialling 01−688 1234 would again be connected, this time to Company Y.

However efficacious the publicity surrounding the change had been, there would be some callers who would not know that the 01−688 1234 number had *(a)* initially become 081−688 1234 and *(b)* later been reallocated to a new customer. This would be unacceptable. By completely withdrawing the old code—01—and introducing two new codes which were previously unused—071 and 081—numbers can be reused with complete confidence.

The release of the 01 code back into the pool of available numbers also considerably increases the possibilities for the future expansion of the national numbering capacity. These options are discussed in a consultative report prepared by OFTEL[2].

Advantages of the Chosen Scheme

The scheme which has been adopted, which retains the existing 7-digit number length and introduces two completely new codes, 071, which will be used for the inner London area, and 081, for the surrounding area, has the following advantages:

- It provides relief in the timescale required and provides sufficient capacity in the areas needed within London for the foreseeable future, and at least until further capacity can be made available during any future expansion of the national numbering scheme.
- It is easy to explain to customers through the use of a simple look-up table, and allows the trapping of misdialled calls and thus the provision of recorded announcements.
- It provides minimum inconvenience since the change can be implemented overnight.
- It is technically achievable within the required timescale and, of the options considered, can be achieved with the least rearrangement of the network.

† CCITT Recommendation E.163 allows for a maximum significant international number length of 12 digits. The UK country code of 44 is two digits in length, and therefore UK national numbers can be up to 10 significant digits in length. However, only 9 digits are currently in use and the tenth digit is reserved for future expansion of the national numbering scheme.

IMPLEMENTATION OF SCHEME

The work which is required to bring the new scheme into operation can be divided into four main areas: network changes, computer support system changes, changes to network-related products and services, and customer communication activities. The work in all four areas will have to be clearly co-ordinated and each of these is described in more detail below.

NETWORK CHANGES

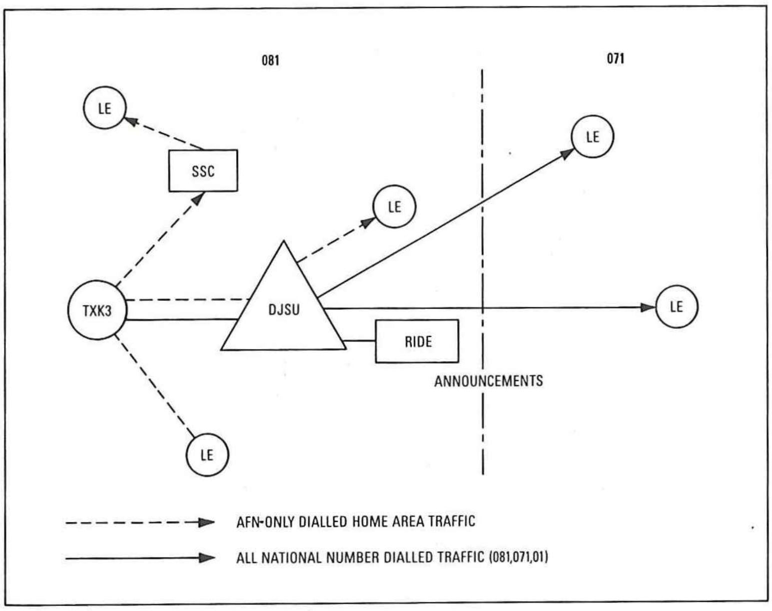
In discussing the network changes required, this article covers firstly the work which is required to provide the necessary routing and translation capability for the new dialling patterns, secondly the work required to provide recorded announcements to assist customers who misdial after the change-over, and thirdly the timetable within which this work will be implemented and the method by which the new codes will be introduced into the network.

In parallel with this work, which is planned specifically for the London code change, the network modernisation programme is continuing. This will greatly assist the London code change since, in general, modernised equipment is more able to handle the new codes than unmodernised equipment. However, the modernisation programme will not be discussed further in this article.

Routing Capability

Most of the exchange systems in use have the inherent capability to handle numbers in the 071/081 AFN XXXX format as it is the same number format as the other major cities such as Birmingham, Manchester, etc.

Figure 3
Routing for a TXK3, post code change



DJSU: Digital junction switching unit
LE: Local exchange
RIDE: Recorded information distribution equipment
SSC: Sector switching centre

However, it was determined at an early stage in planning the code-change implementation that some exchange systems had restrictions which would require modification, or that alternative routing methods would need to be employed:

(*a*) The analogue group switching centres (GSCs) which route trunk traffic via the analogue trunk network require additional digit discrimination/translation capability. As plans already existed to route all trunk traffic via the digital main switching units (DMSUs) before the end of 1990, it was decided that the modification of analogue GSCs to provide additional digit discrimination would only be pursued as a fallback option. The code change will, therefore, be achieved by ensuring that the 01 dialled traffic from outside London, (071/081 dialled after 6 May 1990), will be transferred onto the digital trunk network and will be routed via the DMSUs.

(*b*) The remaining Strowger RT12 exchanges in London which were not capable of handling the 071/081 codes and the national number dialled calls across the 071/081 boundary would be upgraded to RT13 by replacing the RT12s with recovered RT13 equipment from exchanges modernised during 1989.

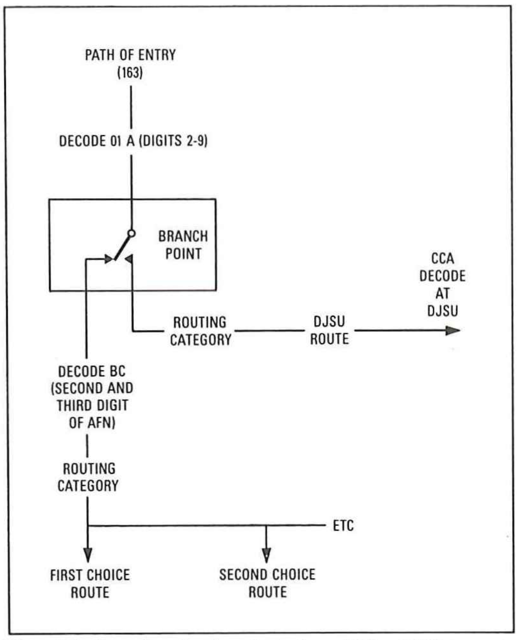
(*c*) The crossbar (TXK3) units have only limited capability to handle national number dialled calls which are not routed via the main route to the DMSU/GSC. Hence, all the cross-boundary traffic across the 071/081 boundary which will be national number dialled would be routed via the digital junction switching units (DJSUs) as well as the changed code announcement traffic (see Figure 3).

System Enhancements

A number of enhancements to the different exchange systems and associated support tools were considered necessary to facilitate the implementation of the code change:

(*a*) In the case of System X DMSUs, DJSUs and digital local exchanges (DLEs), two product improvements were developed by the supplier GEC Plessey Telecommunications Ltd. (GPT). The first was to increase the data table for routing categories to cope with the increased route requirements at the DJSUs to cater for the existing 01 routing, and the 071 and 081 routing from both within the 01 area and from the exchanges on the fringe of the 01 area.

The second improvement provided the capability to switch selected branch points in the digit decode independently of other branch points to allow the switching of the own-exchange identity from 01 to 071 or 081, and to enable the withdrawal of 01 access from 6 May 1990 and the routing of 01 dialled calls to announcements. The provision of this capability enabled switching of specified branch points for the code change independently of other planned uses of branch points, such as re-parenting of concen-



Note: The branch point is switched on 6 May 1990 to route all 01 A (digits 2−9) calls to the DJSU for announcements by a single man−machine language command at each DLE. ABC=AFN (A=digits 2−9, B and C=digits 0−9, excluding 999).

Figure 4—Switching of 01 traffic to changed code announcements (CCAs) at DLEs in London

trators (see Figure 4, which gives a simple illustration of the use of branch points to withdraw 01 access on 6 May 1990). Both of these enhancements were implemented in System X exchanges commencing in July 1989.

(*b*) A data support tool has been produced by BTUK Headquarters Network Operations Support Department (BTUK/NOS3) to replicate the existing 01 digit decode in System X exchanges, and to produce automatically the digit decode necessary to route valid 071 and 081 AFNs and to route invalid AFNs to the appropriate announcements. This data tool greatly reduced the time taken to carry out the extensive data changes required on nearly 200 System X processor exchanges (DMSUs, DJSUs and London DLEs), and virtually eliminated the likelihood of errors being introduced due to the implementation of the extensive data changes.

(*c*) The TXE4 system which, like System X and AXE10, is used in both director and non-director applications, required changes to the control program in main control units (MCUs) to allow 01, 071 and 081 codes to be recognised in the MCUs. In addition, the capability to handle translation search and read-out in the cyclic stores from the current 'x-y' method of working in the same time-slot to a 'y-y' method in adjacent time-slots was introduced, as this enabled spare 'y' slots in the subscribers part of the cyclic store to be used for translations. The implementation of 'y-y' working on TXE4s will greatly increase the translation capability and will, in addition to enabling the code change, facilitate the planned implementation of common-channel signalling (CCITT No. 7) at TXE4 exchanges.

(*d*) The TXS RT13 exchanges had a design capability for 2000 translations, although a capacity for only 1600 was installed. Some of the TXS units will require additional hardware to be installed to increase the translation capacity to 2000.

(*e*) The operations and maintenance centre (OMC), which controls all operations and maintenance functions of System X and AXE10 exchanges, needed the capability to change on an exchange-by-exchange basis the records in the subscribers records system (SRS) to align with the change of the exchange identity from 01 to 071 or 081.

Routing Changes

In addition to the new routes for TXK3 exchanges in London and the need for the digital onload of '01' dialled trunk traffic, some existing routings will have to be changed.

For example, where there is a common route from TXE4s to DJSUs and analogue sector switching centres (SSCs), the route has to be split to allow the necessary digits to be forwarded on the DJSU route to use fully the routing flexibility at the DJSUs and to ensure that appropriate announcements are returned. The current plans to transfer tandem traffic from analogue local exchanges (ALEs) in London on to DJSUs will make it easier for implementing the code change. In particular, announcement traffic to a majority of ALEs in the 01 area will be returned from the DJSUs.

Existing AFNs in the 71X and 81X ranges where the routing digits are forwarded in the AFN XXXX format are being changed to use new routing digits to avoid misrouting when the 071/081 codes are introduced, as the first two digits of the AFN are identical to the 071/081 codes excluding the initial '0' .

Special consideration also needed to be given to traffic to and from other licensed operators (OLOs). In general, the currently agreed interconnect point will be the point of delivery of traffic between BT and the OLOs, and the digit flows will be changed, where necessary, in a phased manner to cater for the introduction of the 071/081 codes. The detailed digit flows, procedures and timescales are currently under discussion with the OLOs.

Summary of Exchange Work

International Switching Centres (ISCs)

Additional translation work (analogue ISCs) or data changes (digital ISCs) will need to be undertaken at the ISCs for the code change. The closure of the Mollison analogue ISC is a critical dependency for the code change because of its limited translation capability.

DMSUs/GSCs

The sequence of events relating to the data changes at DMSUs is given in Table 1.

In the case of GSCs, additional discrimination relays and translation capability is required for the code change. However, as stated above, it is the intention to digitally onload '01' dialled traffic to minimise or avoid altogether modifications to GSCs for the code change.

TABLE 1
Exchange Work—DMSUs

● Provide 071/081 decodes (customer receives number-unobtainable tone if 071/081 dialled).
● Test decode.
—London DMSUs.
—Other DMSUs and associated LEs.
—Selected LEs in 071 and 081.
—Spare AFNs in 071/081.
● Provide recorded information distribution equipment (RIDE) equipment.
● Allow 071/081 routing.
● Comprehensive end-to-end network testing.
● Change-over—enable appropriate announcements.
● Recovery of '01' access and unwanted decode.
● Phased withdrawal of announcements.

DLEs/ALEs Outside London

In the case of most ALEs outside London and its fringe exchanges, there will be no routing/translation changes due to the code change as the routing to London will be handled by DMSUs (and GSCs). DLEs (System X and AXE10), and enhanced TXE4s which have complete route tables for tariff purposes will need their digit decodes/dial code tables modified to include the 071 and 081 AFNs.

The ALEs on the fringes of London (for example, Watford, Epsom) which have direct routes to LEs or DJSUs in London will need changes to their translations to cater for the 071/081 AFNs and for the routing of announcement traffic.

DLEs/ALEs in London

All ALEs (TXE4 RD, TXE4A, TXK3 and TXS) and DLEs (System X and AXE10) in London will need extensive translation and data changes to cater for the code change.

Table 2 summarises the sequence of events which have to be undertaken on TXE4 exchanges and Table 3 the sequence of work on System X DLEs. The work on AXE10 DLEs will follow a similar sequence to System X. In the case of TXE4 RD exchanges, the translation changes involve physical wiring and is an extremely labour intensive activity. The work on cyclic store translations at TXE4 RD exchanges commenced in July 1989 and is expected to continue until the end of 1989.

TABLE 2
Exchange Work—TXE4 RD and TXE4A in London

● MCU programme change.
—To allow identification of own area (for example, 071) and adjacent area (for example, 081) in the cyclic store.
—Enable y-y working for translation.
● Changes to cyclic store translations.
—RD—Physical threadings.
—4A—Automated using scan information decoder (SID).
● Enhancement equipment.
—Changes to dial code tables.
—Change calling subscriber identity to 071 or 081.
● Enable routing using 071/081 as appropriate
—Comprehensive end-to-end network testing.
● Change-over—enable appropriate announcements.
● Recovery of '01' access and AFN only access across 071/081 boundary.
● Phased withdrawal of announcements.

TABLE 3
Exchange Work—London DLEs

● Provide 071/081 decode (customer receives number-unobtainable tone if 071/081 dialled).
● Test own exchange and incoming 071/081 access.
● Retranslate AFN only dialled calls and incoming calls at DLE to use 071/081 decode.
—071/081 XXX XXXX sent between digital exchanges.
● Allow 071/081 routing.
● Change own-exchange decode to 071 or 081 (cutomer's directory number is now 071 (or 081) XXX XXXX).
● Comprehensive end-to-end network testing.
● Change-over—enable appropriate announcements.
● Recovery of '01' access and AFN only access across 071/081 boundary.
● Phased withdrawal of announcements.

London Tandem Exchanges (DJSUs, SSC, Toll B)

In addition to the data changes for the 071/081 codes and associated AFNs, special interim front-end decodes are being provided to cater for the different exchange systems which route calls via the DJSU in the interim phase using different digit flows while the final translations are being implemented. The DJSUs will also route most of the announcement traffic for misdialled calls within the 01 area.

In case of the SSCs, all AFNs which are duplicated in both 071 and 081 after the code change will have their translations to the SSC

prefixed with an '0' to identify the use of the AFN in the 081 area with AFN only (excluding the '0' prefix) identifying the AFN in the 071 area. In order to implement this, existing translations which used '0XX' digits are being removed where necessary. The Toll B tandem exchange which uses RT13 equipment will be modified to increase its capacity to 2000 translations. The additional translations to route 071/081 AFNs and announcement traffic to the Faraday Toll A unit (see below) will need to be provided.

Operator Assistance Centres

Modifications have been planned to analogue operator assistance centres to allow operators to access 071/081 numbers and for the switching equipment to receive 071 AFNs and 081 AFNs from the automatic call recording equipment (ACRE).

In the case of the System X operator services system (OSS), the changes necessary to handle 071/081 numbers will be included as part of the data changes at the System X DLEs on which the OSS is parented.

Hardware Changes

All exchanges will need additional circuits and circuit terminations to cater for the forecast level of misdialled calls which will be routed to announcements (see below).

The additional digits dialled as a result of the code change and the extra number of call attempts due to misdialled calls will need more short holding time equipment (for example, registers and tone circuits). The additional short-holding-time equipments are being provided from equipment recovered from analogue exchanges that have been modernised.

Recorded Announcements

It was decided that the announcements to be provided to customers should be specific where possible and give to the customer an indication of the correct code that should have been dialled. This assumes that, in most cases, the customer would have dialled the correct AFN but the incorrect code. A list of ten announcements have been agreed and these are listed in Table 4.

All ten announcements will be required in London, but only five of the announcements will be necessary outside London.

The announcements will be provided by recorded information distribution equipment (RIDE) provided at the DMSUs for announcement traffic outside London, and at the seven DJSUs and the Faraday Building (Toll A) in London. The Faraday RIDE will cater primarily for announcement traffic from the non-directors on the fringes of London and some central London units. Each of the London RIDEs will be equipped to their maximum capacity of 720 channels of which 650–700 will be reserved for code change announcement traffic. Each of the 58 DMSU RIDEs will be equipped to a capacity of between 120 and 360 channels, depending on the level of traffic forecast. The routing plan for announcements from DJSUs in London is shown in Figure 5.

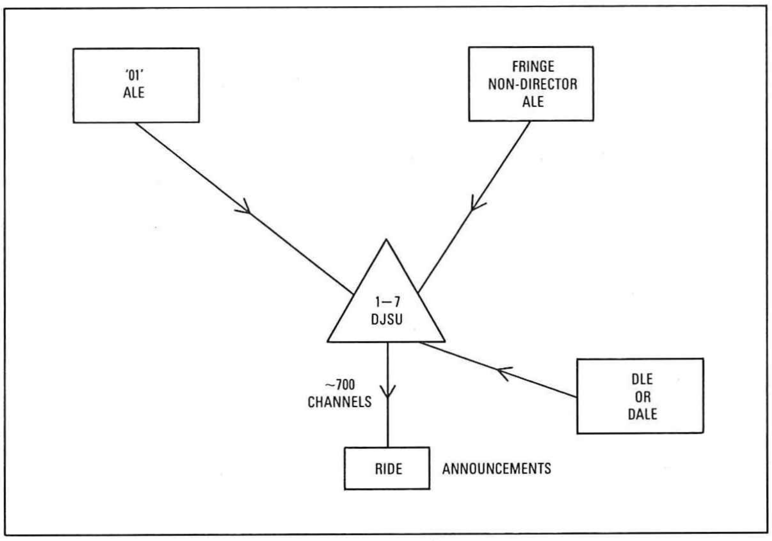
In order to ensure that the network and the RIDE equipment/DJSUs are not overloaded if the level of misdialled calls is significantly higher than forecast, various network traffic management methods are being put in place in digital exchanges including loopback, call gapping and trunk reservation to limit the impact of any traffic surges due to misdialled calls. These measures, together with more basic measures on limiting circuits given access to announcement traffic on TXE4s, will ensure that the network will continue to function routing traffic to the designed levels even if a significantly higher number of misdialled calls occurs in the days immediately following the code change.

TABLE 4
Summary of Announcements

No.	Basic Message
1	Please redial replacing 071 with 081
2	Please redial replacing 081 with 071
3	Please redial omitting 071
4	Please redial omitting 081
5	Please redial replacing 01 with 071
6	Please redial replacing 01 with 081
7	Please redial omitting 01
8	Please redial adding the code 081
9	Please redial adding the code 071
10	The 01 code has been changed to 071 for inner London and 081 for outer London. Please redial using the correct code

Note: All announcements will end with 'British Telecom has not charged for this call'. Announcements 1–9 will be preceded by either 'Sorry, you have used the wrong code', 'The 01 code has been changed', or 'The code for the number you are calling has been changed', as appropriate.

Figure 5
Access to announcements at DJSUs



DALE: Digitally loaded analogue local exchange

Change-Over Day (6 May 1990)

On change-over day, the appropriate announcements will be enabled so that the misdialled calls will be routed to the RIDE equipment in DMSUs, the London DJSUs and Faraday.

The 01 access and AFN-only dialled access across the 071/081 boundary will then be progressively withdrawn.

Timetable

The network changes required for the code change are extensive and a considerable degree of co-ordination of the work being done on the different exchange nodes (local, tandem, trunk and international) and the various system types is essential for successful implementation. This has, therefore, required detailed planning and management to ensure that work is implemented in a phased but controlled manner. This has also enabled the code change workload to be managed in addition to existing programmes such as modernisation with minimal disruption.

A need was identified for a period of parallel running where the 01 and 071/081 codes were operational for specialist users such as alarm companies and changes required to major customer premises equipment (CPE) products (for example, large PBXs)—see Products and Services Changes below. This, together with the desire to keep to a minimum the network activities during the weekend of 5–7 May 1990, has resulted in the planned completion of most network activities including testing by 2 April 1990 (other than specific work that must be carried out on 6 May 1990).

The planned timetable for the various network activities is shown in Table 5.

The network changes will therefore be introduced in a phased manner. However, not all changes will be completed and tested prior to change-over day; therefore, the key message of the customer communication campaign is that the London code change will take place at 'one minute past midnight on 6 May 1990'. The last phase of network changes and the withdrawal of the 01 code will start immediately after midnight on 6 May 1990 and be completed by 11 May.

TABLE 5
Timetable for Network Activities

Commencement of network changes	July 1989
Completion of data/translation changes on all system types	December 1989–January 1990
Modify own-exchange identity and allow routing of 071/081 calls	January–February 1990
Complete all physical activities on the network	28 February 1990
Full end-to-end testing of network	1 March 1990–2 April 1990
Enable routing to appropriate announcements	6 May 1990
Withdraw all 01 access	6–7 May 1990
Withdraw all AFN-only access across 071/081 boundary	6–11 May 1990
Monitor announcement traffic and withdrawal of announcements (precise timing dependent on level of announcement traffic)	Late 1990

COMPUTER SUPPORT SYSTEM CHANGES

Right from the outset, it was clear that many of BT's internal computer support systems would require modification to handle the London code change. It was also clear that it would not be possible, practically, to project manage the changes to all these systems centrally.

Therefore, a simple classification of systems was identified:

(*a*) *Category A* systems are those which are not affected by the code change because they do not contain telephone numbers or they will be obsolete by 6 May 1990. Clearly, these systems require no action.

(*b*) *Category B* systems are those which contain telephone numbers and therefore which will be affected by the code change. However, these are not considered critical either because the telephone number is not used in a customer-facing or revenue-managing function, or because the changes can be handled within the normal maintenance procedures for the system. Changes to category B systems will not be project managed centrally.

(*c*) *Category C* systems are those which are considered critical to the code change, because they contain telephone numbers which are used in a customer-facing or revenue-managing function, and the changes required cannot be covered within the normal maintenance procedures for the system.

Twenty systems within BTUK have been classified as category C systems. Categorised by application area, these are:

- operations support and finance: CSS, CAPPS, NAD and TIBS.
- network: CALLDATA, LLIS, CARROLL, OMC2, SXCC, SXCSOLO, TDX, NCDB, CATMAC, MAC and JNS.
- operator and directory services: DAS, DCA, NIS, Sequin and Answers.

Changes to these systems are being project managed centrally. Apart from their critical nature, as described above, these systems are all inextricably interlinked and each must change in synchronisation with another. A detailed plan is in place for the changes to these systems, and they will be modified according to a strict timetable which ensures that each system is updated at the appropriate time.

For the first time on any large scale within BT, an integrated test will be carried out before the code change date, to ensure, so far as is possible, that each computer support system can

interwork in its new formats with each other. In the past, there has not been a need for a synchronised change to computer systems, and therefore each computer system has tended to be tested in isolation.

In addition, to cover the unlikely possibility where a system fails to convert on the planned date, a system of filters has been built onto the front end of each critical computer system. This means that a system which receives information in the incorrect old 01 format from a system which has failed to convert will be able to convert that input into the new 071 and 081 format.

CHANGES TO NETWORK-RELATED PRODUCTS AND SERVICES

A number of products and services will need to be modified as a result of the London code change. This will include certain items of customer premises equipment (CPE). The most common changes will be to short-code dialling, call barring, equipment identity codes (for example, on facsimile terminals) and route optimisation. Many of the changes to telephone memories and facsimile identity codes are simple, and customers will be able to carry these out without difficulty. Some, however, will require an engineering visit.

Having taken account of the regulatory requirements and the desire to meet customers' requirements at minimum cost, a policy has been agreed whereby BT will carry out these modifications free of charge, provided that several conditions are met. Firstly, the equipment must be rented, subject to first year warranty or maintained by BT. Secondly, customers must not be able to make the changes themselves, and the facilities to be adjusted must already have been invoked on the equipment and be within its design limits. Thirdly, where BT has a contract to maintain equipment supplied by a third party, BT will not charge for changes which BT engineers can make, but a charge will be levied if additional hardware or software is required from the third party supplier. Finally, this policy applies only to modifications necessary owing to the London code change, and will only apply until 30 June 1990.

A particular problem arises with respect to alarm systems which dial into the 01 area, or which will dial across the 071/081 boundary. There are approximately 100 000 burglar alarms which fall into this category, and it is clearly impossible for the alarm companies to modify the autodiallers concerned on the night of 5/6 May 1990. To minimise the cost of accommodating the London code change, alarm systems suppliers would ideally wish to reprogramme their equipment during the normal six monthly maintenance visit which they are required to make under BSI regulations. To do so, they would require a period of nine months parallel running of the old 01 code with the new 071 and 081 codes.

The timescale for the implementation of the project means that it is not possible to accommodate such a long period of parallel running. To ensure that exhaustion of the London numbering scheme does not occur, the code change must take place in the spring of 1990. Although engineering work on the network began as soon as agreement to the scheme had been obtained, as has been discussed above, this work will not be completed and tested until the end of March 1990. Thus nine months parallel running cannot be provided before the change-over date. After 6 May 1990, parallel running cannot be provided since the 01 codes must be withdrawn to ensure customers are fully accustomed to the new 071 and 081 dialling patterns before it is necessary to duplicate AFN codes to provide new capacity.

After consideration of this problem, and detailed discussions with the alarm systems industry, BT recommends that alarm systems companies should overcome this problem by transferring to the LinkLine 0800 service, which is provided over the digital derived services network (DDSN). The advantages of this approach are firstly that 0800 numbers can be provided early to give nine months of parallel running. Secondly, the DDSN has short post-dialling delays to ensure that the alarm devices do not time out. Thirdly, future developments will provide enhanced network security as alarm companies will be able to arrange for incoming calls to be diverted to a secondary central station if necessary, say for reasons of security or cost efficiency.

CUSTOMER COMMUNICATION ACTIVITIES

In a sense, the engineering and technical aspects of the code change are the least important. However well these are carried out, if the change is not communicated effectively to customers, the code change may rightly be considered to have failed. A considerable customer communications programme is therefore also included in the overall plan for the code change.

The first phase of the publicity was carried out in April and May 1989, and consisted of a direct mail letter sent to all 01 customers, press advertising and a large media briefing campaign.

Further phases of the campaign will include a reminder letter to business customers, late in 1989, covering those aspects which should be handled at that time, such as plans to reorder stationery and other literature, and to inform business contacts of an organisation's new codes. This will be followed by a campaign which will consist of press, poster and TV advertising, and further direct mailings which will build to a peak on the weekend of 5/6 May 1990. The campaign will focus not only on London, but also on the rest of the UK and indeed the rest of the world.

Throughout, BT's aim is to give customers the maximum information they need at the earliest opportunity with the utmost clarity.

SUMMARY

Thus it can be seen that the London code change is an enormous project requiring major work in a large number of areas. It is obviously critical that the network, support system and product and services activities are completed on time and to specification. They must also be planned and implemented in a manner which is easily understood by customers, and supported by a comprehensive customer communication campaign, to ensure the overall success of the project.

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Biographies

Millie Banerjee is the project owner of the London code change, and the District General Manager of the London Network Operations (LNO) District. London Network Operations District is responsible for managing the network in London, which includes all local, trunk and tandem exchanges as well as the trunk and junction network. She joined BT in 1970 from university and was employed as a Telecommunication Traffic Superintendent in BT International. After a short career in the training division, teaching at the Management Training Centre, she joined London Region in 1980 as a Head of Section on Marketing Intelligence. She was then appointed as Deputy General Manager in London South West Area. When the Districts had been established, she joined the Southern London District as Deputy District Manager, after which she was appointed District General Manager for London Networks in 1987. She has a Degree in Zoology and a Master's Degree in Management Science.

Rabi Rabindrakumar is the sub-project manager for the LNO aspects of the London code change and is the manager, project evaluation for the LNO. He joined BT in 1970 and worked on exchange planning and design aspects of TXE4 and TXE4A electronic exchanges, and subsequently System X exchanges. In 1980, he was seconded to the Hong Kong Telephone Company as a Senior Engineer on digital switching, and was responsible for the preparation of the technical specification for an international tender for digital local and tandem exchanges and an international toll exchange, and the evaluation of the tenders. He returned to BTUK HQ in 1983 and headed a group responsible for System X digital concentrators, customer facilities and interworking, and was later responsible for the technical specification of digital exchanges. He is a Chartered Engineer and a Member of the IEE.

Bernard Szczech is the project manager for the London code change. After leaving university, he joined Logica plc, an information technology consultancy, where he held a number of roles in software development, software project management, product management in word processing systems, and marketing consultancy. He joined BT in 1986 and was appointed as business planning manager for BTE Merlin and subsequently UK Communications headquarters. He was then appointed as the implementation support manager for total quality management in BTI Overseas Operations, before taking up his present role. He holds an MA in Geography and Computer Science from Cambridge University and an MBA from the London Business School.

The Digital Derived Services Intelligent Network

S. WEBSTER†

Enhancements to the digital derived services network (DDSN), using intelligent network architecture and a central network database, will enable a range of advanced freephone services to be provided. This article describes the architecture and the operation of the DDSN intelligent network, and outlines the new features.

INTRODUCTION

In 1983, British Telecom identified a major market potential for automatic freephone and premium rate services. An analogue network, with extended register translation and call charging facilities overlayed on the public switched telephone network (PSTN), was proposed as an interim solution. The analogue derived services network, consisting of eight fully-interconnected switching nodes, was brought into limited public service in April 1985 and full public service in July 1985.

The LinkLine™ 0800 service permits calling customers to make calls free of charge while callers to LinkLine 0345 service numbers are charged at the local call rate irrespective of distance. The balance of the call charge is billed to the called customer known as the *service provider* (SP).

In keeping with its business modernisation programme, British Telecom awarded a contract to AT&T for the supply and installation of a digital derived services network (DDSN), comprising 5ESS-PRX digital switches to be implemented in two distinct phases:

Phase 1, which was completed in 1988, involved the supply of eight digital units, utilising CCITT No. 7 common-channel signalling, as replacements for their analogue units (Figure 1). In addition, two new digital units were provided in London.

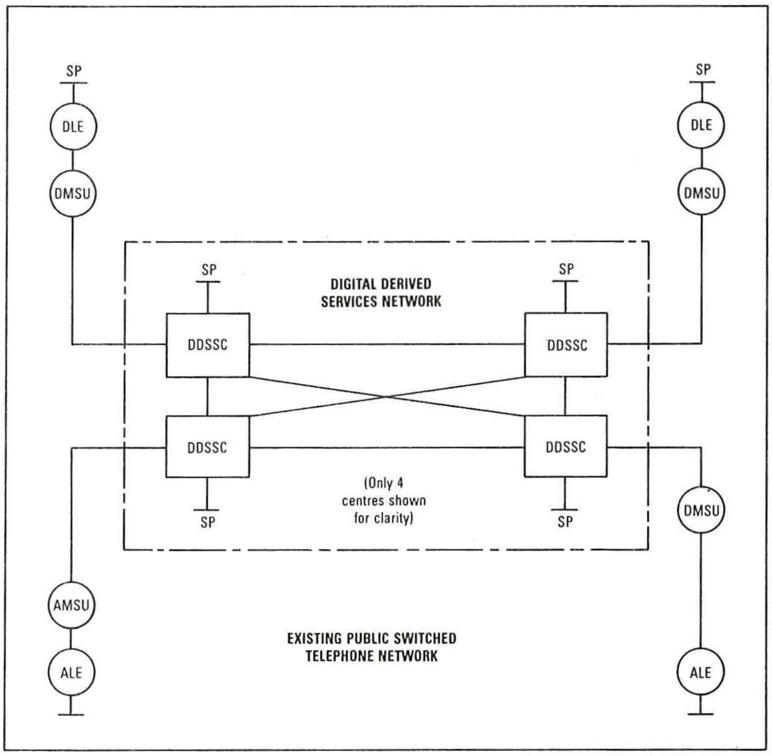
Phase 2 makes provision for an advanced freephone service using an intelligent network architecture.

INTELLIGENT NETWORK CONCEPT

In a traditional telecommunications network, call control 'intelligence' resides in the call processing software in its switching nodes. One disadvantage of this approach for some services is that customer-specific data has to be replicated in each node. As features become more sophisticated, then system complexity increases. In the DDSN intelligent network, specialised customer feature and routing information is held centrally in a network database which can be accessed by all switching nodes using dedicated datalinks and common-channel signalling (Figure 2). These signalling datalinks are used to pass requests for call handling information to the database and return instructions to the originating switching node.

An intelligent network centralised call management function allows an economical implementation of advanced features, simplifies administration for complex services and assures optimum use of network-wide, rather than switch-based, resources.

Figure 1
Digital derived services network interconnection

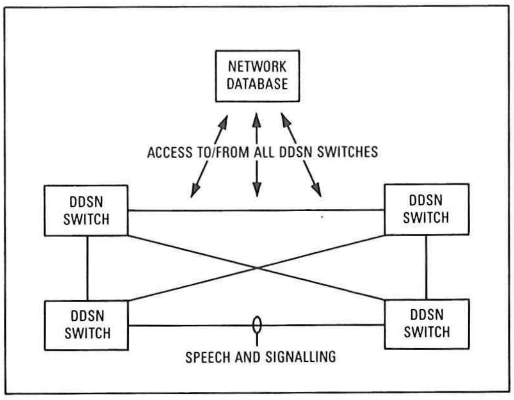


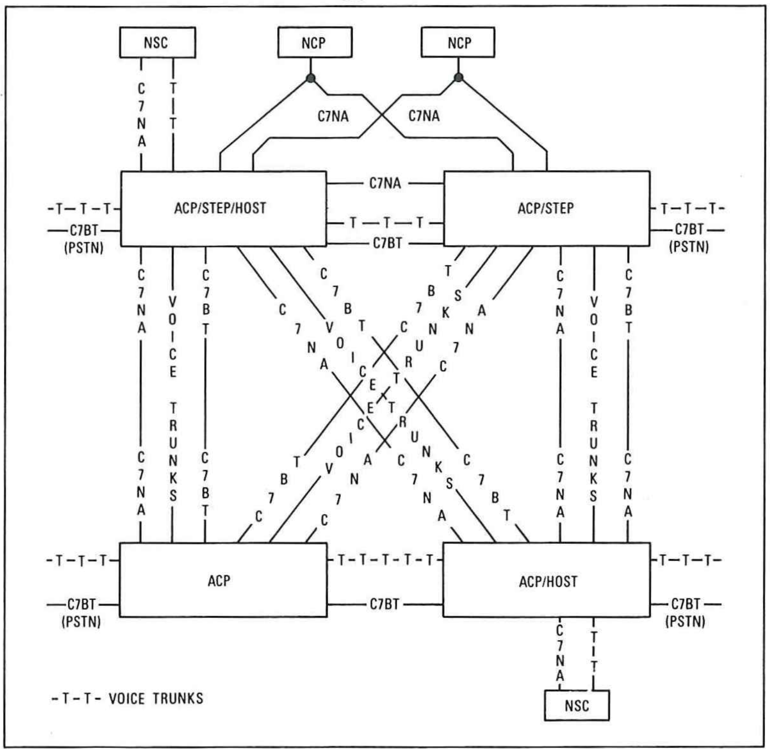
AMSU: Analogue main switching unit
ALE: Analogue local exchange
DDSSC: Digital derived services switching centre
DLE: Digital local exchange
DMSU: Digital main switching unit
SP: Service provider

† Network Systems Engineering and Technology, British Telecom UK

™ LinkLine is a trade mark and a service mark of British Telecom

Figure 2
Network database concept

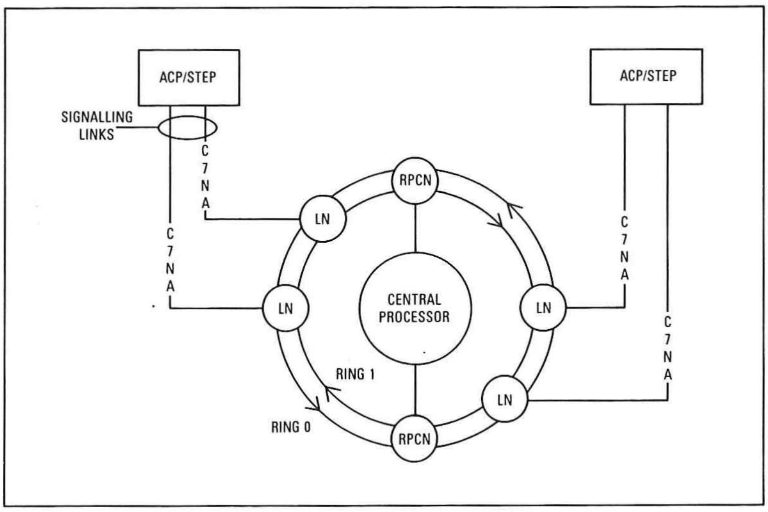




ACP:	Action control point	NCP:	Network control point
STEP:	Signal transfer and end point	NSC:	Network services complex
C7BT:	CCITT No. 7 signalling (BT)	C7NA:	C7 North American

Note: Only four switching nodes are shown for simplicity

Figure 3—DDSN intelligent network architecture



LN: Link node RPCN: Ring peripheral controller node

Figure 4—Common network interface ring

DDSN INTELLIGENT NETWORK ARCHITECTURE

Three network elements are concerned with call processing for service providers with advanced features:

- action control point (ACP),
- network control point (NCP), and
- network services complex (NSC).

The network architecture is illustrated in Figure 3, and the role of each of the elements will become apparent as the call processing aspects are explained.

Action Control Point

The action control points (ACPs) are the 5ESS-PRX switching nodes, which serve as transit and terminating nodes for DDSN traffic. All ACPs are fully interconnected by digital line systems and CCITT No. 7 (BT) common-channel signalling. The CCITT No. 7 (BT) signalling links are used exclusively for setting up speech paths both within the DDSN and between the DDSN and the PSTN.

A second totally independent common-channel signalling network, utilising a proprietary form of No. 7 signalling (C7 North American), is used for transporting non-circuit related signalling messages between the ACPs and the network control points (NCPs). This network is used only for advanced feature calls. Two of the ACPs have been nominated as a signal transfer and end point (STEP) and funnel the signalling traffic from the remaining ACPs to the NCPs. ACPs load share the C7NA signalling messages across both STEPs in the ACP-to-NCP direction, and the NCPs load share the signalling messages across both STEPs in the reverse direction.

Network Control Point

The network control point (NCP) constitutes the core of the intelligent network and holds the data defining the treatment for specific advanced feature calls. NCPs are always provided in mated pairs.

Each NCP consists of a duplex processor, duplicated hard discs for data storage, tape drives and interfaces to the other network elements through a local area network. This network, called the *common network interface*, consists of the signalling terminals for the C7NA links from the STEP nodes and two peripheral controllers which communicate with the duplex processor. The common network interface ring (Figure 4) is automatically reconfigured under fault conditions to isolate the faulty section.

Advanced freephone call handling data is duplicated both within and between each NCP in the mated pair. Call routing queries from the ACPs are balanced between the two NCPs by designating specific dialled codes to each NCP, and the decision on which NCP to query is taken

at the ACP where the call entered the DDSN network. Although data is held on both NCPs, the secondary NCP is only accessed if the primary is not available. Under these conditions, the remaining NCP is capable of handling 100% of the load. This architecture virtually guarantees 100% service availability.

Automatic network management controls initiated by the NCP maintain the integrity of the intelligent network under overload conditions by sending code gapping messages instructing the ACPs to throttle back on the number of queries being forwarded to the NCP and defining the treatment for the failed calls.

Network Services Complex

The network services complex (NSC) provides the capability to give callers standard or customised interactive spoken information pertaining to the number called, such as, call prompting, courtesy response and call queueing announcements. During or after a call prompting announcement the caller may communicate with the NSC by keying-in appropriate digits on a multi-frequency keyphone or keypad. The NSC can collect up to 15 digits which it forwards, via its host ACP, to the NCP via a C7NA common-channel signalling link.

Initially, two NSCs loaded with the same announcements have been provided in the DDSN intelligent network and are co-located with the NCPs. Each NSC can handle 60 simultaneous calls and provide up to 2000 different announcements which are stored on triplicated moving head discs. In the event of an NSC failure, calls requiring these features are routed to the remaining NSC.

The NSC architecture is given in Figure 5.

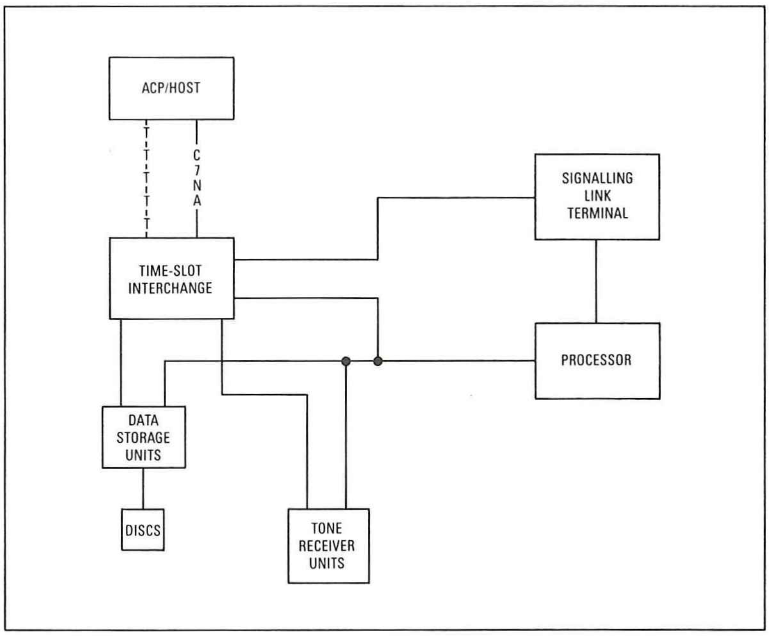


Figure 5
Network services complex architecture

ADVANCED FEATURES

The DDSN intelligent network will permit a range of new features to be offered as Advanced LinkLine to LinkLine service providers. These include (Advanced LinkLine feature name in brackets):

Time and Day Routing The routing of calls can be made dependent on the time of day, day of week and week of the year. (TimeLink/DayLink)

Call Allocator This provides the capability to route incoming calls proportionally to a number of service provider destinations and/or announcements. (DistributionLink)

Call Queueing This provides queues for calls at the originating ACP when all available lines to a service provider destination are engaged. An announcement informs the caller of the calls status. (QueueLink)

Call Barring This feature allows service providers to define the treatment of a particular Advanced LinkLine number based on where the call originated in the PSTN. (AreaLink)

Alternative Destination On Busy When a busy condition is encountered and no queueing is defined, an alternative destination may be chosen automatically. (BusyLink)

Call Prompter Announcements will prompt callers to enter digits on their telephone set in order to realise caller interactive routing. (SelectLink)

Courtesy Response If no destination can be reached, for example, due to an unattended office, a pre-defined standard or customised announcement may be played. (CourtesyLink)

Command Routing This feature allows the service provider to instruct British Telecom to redirect calls to a preset alternate set of destinations. This is intended for emergency and other contingency situations. (CommandLink)

CALL ROUTING PLANS

The true power of intelligent network call processing is not solely its list of advanced features, but combinations of the feature set which can be defined to meet a service provider's own unique telecommunications needs and, consequently, business requirements. An example of a simple call routing plan is shown in Figure 6. The data defining the call treatment(s) for a service provider are held in the NCP database in a service provider record.

SERVICE ADMINISTRATION

Service administration for Advanced LinkLine features is handled by the network subscriber transaction, administration and recording system (NETSTAR), which has on-line access to the NCPs. NETSTAR provides user-friendly access to the NCP advanced feature database to modify, create or delete service provider call routing plans via dedicated or dial-up/dial-back links to visual display terminals. An NCP can have only one active call routing plan for any service provider number, but additional plans may be prepared and held in NETSTAR for

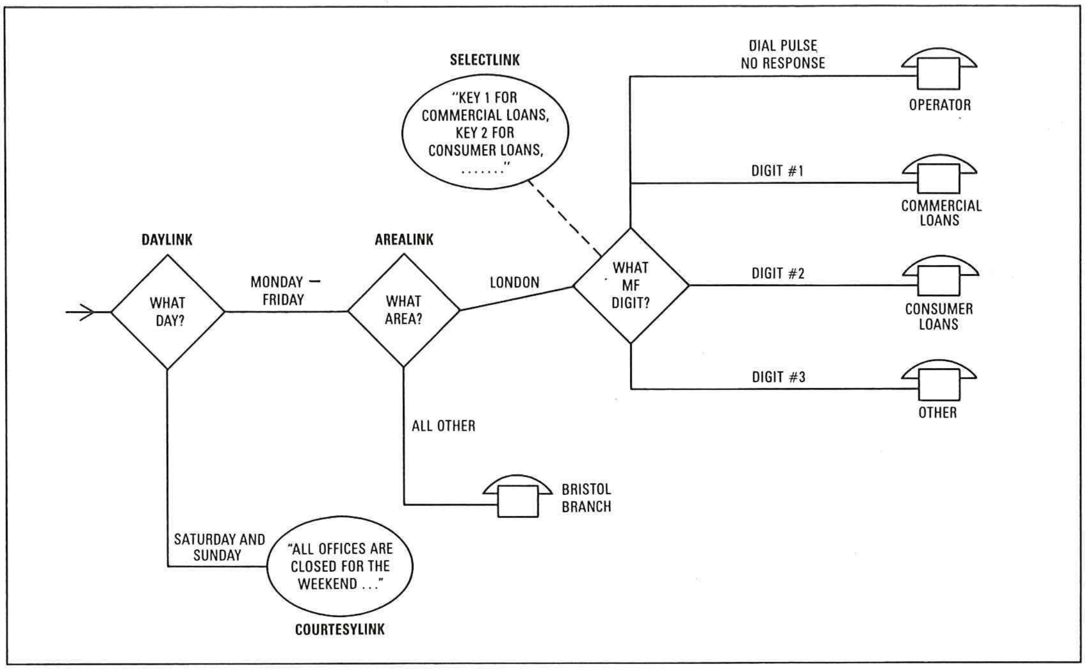
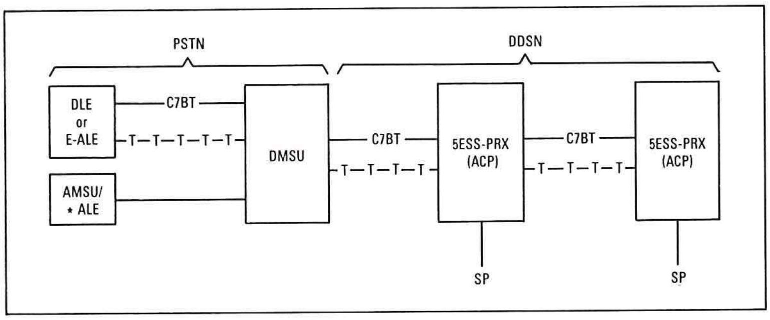


Figure 6
Combining service features

transmission to, and activation at, the NCP when required. NETSTAR holds security backup copies of all call routing plans and NCP operating parameters.



* ALE may be via a digital concentrator centre exchange
E-ALE: Enhanced analogue local exchange (C7BT signalling capability)

Figure 7—Access to the digital derived services network

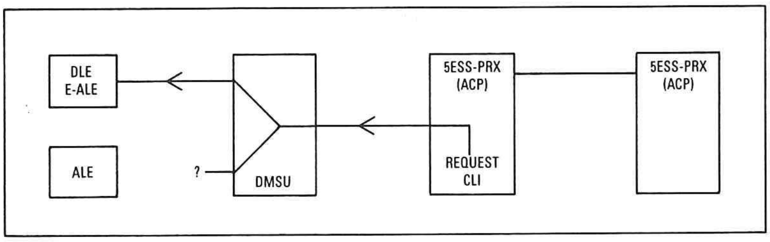


Figure 8—CLI derivation

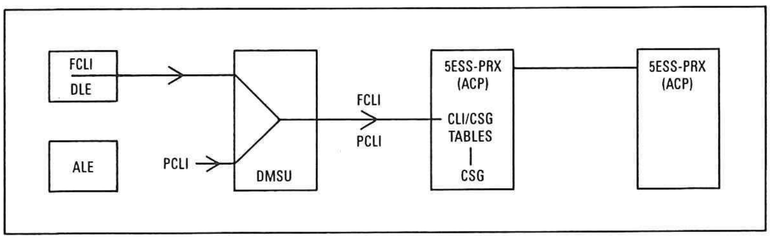


Figure 9—CSG derivation

CALL PROCESSING

Derivation of the Calling Subscriber Geography (CSG)

All 0800 and 0345 calls are routed via a DMSU to a DDSN action control point (ACP) (Figure 7). During call set-up, the ACP requests *additional set-up information* to be sent via the C7BT link. This causes the calling line identity (CLI) to be forwarded from the first exchange in the call path with C7BT signalling.

If a call is originated from a local exchange with C7BT signalling, a full calling line identity (FCLI) is returned to the ACP. The FCLI includes the caller's national number group (NNG) code or all-figure numbering (AFN) code, in the case of a director area.

If a call is originated from an analogue local exchange (ALE), then a partial calling line identity (PCLI) is derived by the first digital exchange in the call path. This will normally be a DMSU, but in cases where an ALE is parented on a digital concentrator centre exchange (DCCE), the DCCE generates the PCLI. A PCLI must comprise sufficient information to uniquely identify the digital entry point to the PSTN used by that ALE. This information includes the region, area and unit identity portions of the network nodal identity plus the telephony process number and route numbers used by the call processing software of the digital exchange.

When a PCLI or FCLI is received by a DDSN action control point, the call processing software searches through a set of look-up tables for a comparison with the CLI sent. This search will result in the calling subscriber geography (CSG) being identified.

Figures 8 and 9 illustrate the CLI and CSG derivation process.

Global Title Translation (GTT)

Call processing for service providers with basic features is handled within the DDSN switching nodes. To differentiate between calls to SPs with advanced and basic features, the ACP checks for the existence of a translation for the number dialled. If a translation exists, the call is routed to the specified network termination. If the translation does not exist, call handling instructions are returned from the NCP database in response to a query message from the originating ACP. A number of query messages are necessary for some types of call; the initial query is therefore termed *QRY1*. The process is illustrated in Figures 10 and 11.

The QRY1 message includes:

(*a*) 10-digit dialled number, which excludes any leading 0 but includes a trailing 0 as padding if only 9 digits long.

(*b*) Calling subscriber geography (CSG).

(*c*) The ACP which originated the query. This is used to reference a table in the NCP which defines the capabilities of the ACP; for example, whether it has an NSC.

(*d*) The destination of the query.

The route message includes a network code of up to 10 digits which is used by the ACP to route the call to its destination. This is normally a service provider (SP) line but can be an NSC announcement.

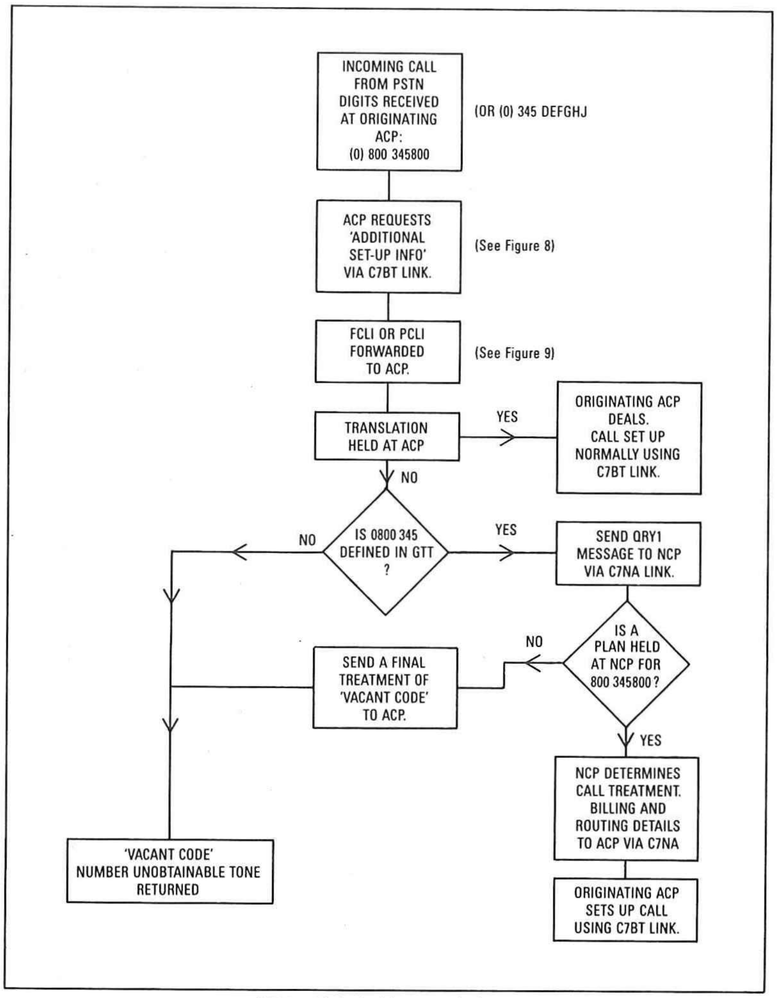
A final treatment command is sent to the ACP when the NCP cannot route a call normally. The final treatment command results in either a tone or an announcement being returned to the caller.

Calls Requiring an NSC

As not all ACPs are hosts to an NSC, a call which requires an NSC at some point during the call treatment must be set up in two parts. After the QRY1 message, the call is routed to an ACP/HOST, using C7BT in the normal manner, where a voice trunk to the NSC is allocated. This action is termed a 'service assist' if the NSC is required as an intermediate step in the call treatment (SelectLink) or a 'hand-off' if the NSC is required to play an announcement as the final routing conclusion (CourtesyLink). During a service assist or a hand-off, the ACP/HOST then queries the NCP a second time (QRY2) with details of the NCP and call number used for the QRY1 message. The call treatment now continues with a list of commands being sent from the NCP to the NSC. This could be to play an announcement and collect digits from the caller. NCP/NSC communication takes place via the C7NA links with any digits collected being returned to the NCP to determine the final disposition of the call.

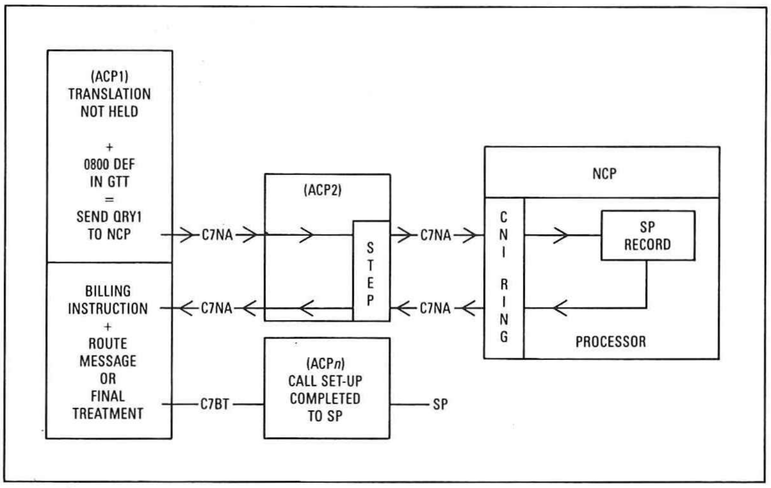
CALL LOGGING

In response to a query message from the originating ACP, the NCP returns a billing command



GTT: Global title translation

Figure 10—DDSN intelligent network call processing (call not requiring NSC and no network controls active)



ACP1 = ACP receiving call from PSTN
ACP2 = ACP with directly connected NCP
ACP*n* = The ACP on which the service provider is terminated

Figure 11—ACP communication with NCP

instructing the ACP what details to record; the ACP acknowledges receipt of the instructions to the NCP. On answer, the terminating exchange sends a message to the originating ACP giving either 'answer/no charge' or 'answer/charge' depending on which LinkLine service (0800/0345) is defined. On call termination, the

ACP records the details of the call in an automatic message accounting (AMA) record.

The originating ACP normally controls the call and is responsible for generating an automatic message accounting record. These records are periodically polled by an on-line data collector which validates them before passing them to an off-line charge raising system which calculates call charges in preparation for the production of the service provider's bill. Where a 'hand-off' has occurred, the ACP/HOST takes over control of the call for supervisory and logging purposes.

OPERATIONS AND MAINTENANCE

The multi-function operations system (MFOS) is central to the operations and maintenance functions for the DDSN intelligent network. These functions include:

- on-line access to the ACPs/NCPs/NSCs,
- alarm collection and monitoring,
- collection and analysis of traffic data, and
- real-time network management.

Connection between the multi-function operations system processors, the network elements and the users is achieved using a virtual circuit switch for flexibility.

CONCLUSION

The DDSN intelligent network is the most sophisticated network of its type outside North America. The flexibility of the centralised call management system will permit British Telecom to respond faster to the increasingly more exacting requirements of its customers. It will be possible to deploy new features more quickly and with little or no impact on the switching nodes themselves.

ACKNOWLEDGEMENT

The author wishes to express his thanks to AT&T NSUK Ltd., the DDSN project team, operational departments and all staff who have assisted in the preparation of this article or have been involved with the installation, proving and commissioning of the network.

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Biography

Steve Webster joined BT City Area in 1972 from Plessey Telecommunications Ltd as an installation and maintenance technician on crossbar switching systems. In 1978, he transferred to Service Division in Headquarters where he was part of a small team which investigated maintenance and quality of service problems. This work included acceptance testing of measurement and analysis centres. He was transferred to the System X Launch Unit in 1980 to work on maintenance aspects until returning to London District in 1984 to supervise the installation and commissioning of the initial analogue and digital derived services switching centres. He joined the Derived Services Network Project Team in 1986 to assist with project control and is currently involved with the implementation, commissioning and evolution of the DDSN intelligent network.

Provision of Telecommunication Service in a Competitive and Deregulated Environment

A. R. VALDAR†

The presence of competition and the degree of deregulation affect the way that a telecommunications administration offers service to its customers. The growth of competition and the changes in the regulatory regime have been dramatic in the UK over the last few years. Now there are signs that similar changes are already beginning in the rest of Europe. This article describes how British Telecom has coped with the changing environment in which it operates, and draws conclusions which, it is hoped, will be of interest to the other European administrations. This article is a revised version of a paper presented to the FITCE Congress in Athens in September 1987.*

In considering the areas under threat from competition, the article examines the effect of new digital technology on the services that are offered and the position of the network boundary. The latter is particularly important now that digital transmission is being extended to the customer's premises. This results in the location of electronic network termination equipment in the customer's premises which present standard interfaces for terminals, such as PABX and digital data multiplexers. As will be described in the article, it is important for the administration to define the customer—network boundary with care so that the functions supporting service provision and maintenance are retained within the network while allowing reasonable degree of freedom to the terminal manufacturers.

INTRODUCTION

The presence of competition and the degree of deregulation affect the way in which a public telecommunication operator (PTO) offers service to its customers. In the UK, the introduction of competition and changes in the regulatory regime have had a dramatic effect over the past few years on the provision of telecommunications services. The process began with the liberalisation of the supply of data modems for attachment to leased circuits and later to the public switched telephone network (PSTN). The supply of large PABXs was similarly liberalised. This state of affairs continued until 1981 when, by act of parliament, competition was introduced, including basic network competition from a second carrier. At that stage, the UK government made a clear distinction between network services, which were to continue to be regulated, and the provision of attachments to the network which were to become deregulated. In addition, following the act, value-added services were licensed.

Now, similar changes are beginning in the rest of Europe. Recognising this, the European Commission has prepared a Green Paper which paves the way for significant changes in the internal telecommunications market by 1992. It is hoped that implementation of the proposals in the paper will lead to the creation or a large unified home market and to stimulate new telecommunication services.

THE OPERATING ENVIRONMENT

The environment in which a PTO operates is defined by the regulatory regime and the authority established to police it, the presence of other PTOs, operators of value-added services, the telecommunications apparatus manufacturers and, of course, the customers. Each of the parties involved has different objectives and interests. It is illuminating to consider each, briefly.

The PTOs

The objective of a PTO, stated briefly, is to provide telecommunication services in accordance with the stipulations of its licence so as to meet customer needs in a commercial business manner. An important aspect is that PTOs expect to get reasonable returns from the high cost of establishing a national network infrastructure which tends to encourage them to protect investment in existing networks where possible.

The Regulatory Authority

The regulatory authority, set up by the government, will establish rules for the provision of network services and will govern the way that PTOs implement these services. This set of rules

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* VALDAR, A. R. A Telecommunication Administration's Approach to Competition and Deregulation. FITCE *Revue*, 1988, **27**(1), p. 43.

will not only define the regulated activity, but also the way in which a PTO may charge its customers and the way that the PTOs interact with each other. The latter is seen as particularly important by a new PTO because the high cost of entry into public telecommunications is such that some form of linking between its embryonic network and established networks is vital. (This may not be a view, though, which is totally shared by an established PTO, who may see such linking as giving too much of a helping hand to an emergent operator.)

The Value-Added Service Operators

The aim of the value-added service operators is to provide some additional functionality from a small number of locations (nodes) which, accessed via a basic service from a PTO, enables a niche market need to be met. Therefore, the value-added service operator has direct control over only its nodal equipment (containing facilities for mailbox, bureaux, store-and-forward, etc.) and must rely on the PTO to act as its agent in providing transmission and basic switching to and from its customers.

The Telecommunications Apparatus Manufacturers

The manufacturers of telecommunications apparatus are concerned with producing equipment to exploit the market opportunities offered by modern telecommunications networks to give a progressively widening range of services and features for customers. This is an area of particularly rapid change, due both to the availability of inexpensive intelligence (processing and storage) and the very competitive nature of intelligence-based equipment. In fact, the driving force for liberalisation of these attachments is the potentially immense telecommunications market in which customers may benefit from the wide choice of network and computer terminal equipment increasingly available world-wide.

The Customers

Customers clearly want communications services that will meet their particular needs and applications. However, customers' requirements are not homogeneous: they have a wide range of differing applications, needs and expectations. Many customers consider price the most important factor, while others may consider service features, performance, security and so on, to be more important. One of the objectives of deregulation and the introduction of competition should be to give customers a realistic choice in meeting their needs and hence optimise their own business interests. Understandably, the needs and aspirations of the various parties described above sometimes conflict and the government's approach to balancing the various pressures has, of course, a political element. Furthermore, the above environment tends not to be stable for long. For example, there is a continuing pressure for new network or value-added-service operators to enter the scene, the regulations will be amended, and, not least, governments change.

CURRENT ENVIRONMENT WITHIN THE UK

Currently, there are three (fixed network) PTOs: British Telecommunications plc (BT), Mercury Communications Limited (MCL) and Kingston upon Hull Telephone Department (KHTD). In addition, there are two cellular radio operators: Cellnet (in which BT has a majority share) and Racal Vodafone. A number of cable TV companies are now operating in defined areas of the country distributing broadcast TV and providing, in conjunction with the PTOs, telephony services. There are several licensed value-added services (VAS) operators which cover services such as electronic mailbox and radiopaging. The provision of all telecommunications apparatus, that is, attachments, is liberalised and there is now a wide range which have been approved for connection to the network.

Although the PTOs are solely responsible for the maintenance of network service, customers may choose from a range of registered maintainers whom they wish to maintain their attachments.

THE EFFECTS OF DEREGULATION ON THE PROVISION OF TELECOMMUNICATION SERVICE

The provision of overall telecommunication service comprises the combination of transmission through the network and appropriate attachments (terminals). Where the PTO owns and provides the attachments, a particular service can be achieved with the functionality between network and attachments allocated to ensure that the overall service requirements are met. This may result in the allocation of functions between network and attachment differing for different services and for different PTOs. However, in a liberalised environment where the provision and ownership of the attachments is deregulated, the PTO is constrained in the way that service may be offered. Also, in the latter case, the customer then has two, or maybe even three, parties involved in the provision of the service, namely the PTO, the attachment provider, and the attachment maintainer. The picture may be further complicated by the additional presence of service providers (for example, with LinkLine services) and a second PTO involved in the provision of the network service.

The following discussion compares the two regimes on the various aspects of service provision.

Performance

The performance of the service seen by the customer is a combination of the performances of the network element and the attached customer apparatus. In the case of telephony, for example, the perceived overall transmission performance is a combination of that of the telephone transmitter and receiver and the network which interconnects them. Where both components are owned and provided by the PTO, the choice of apparatus offered to customers would be restricted to those that strictly adhere to the particular requirements of the network.

The effects of deregulation are best considered separately for PSTN and leased-line services.

(*a*) *PSTN* A telephone connected to the PSTN must be able to communicate with any other telephone on that network, or indeed on other networks within that country or abroad. In a deregulated regime, a call connection could then include the network linkage of two telephone attachments, each of which is supplied by a different manufacturer and of different design. The system of approval must, therefore, ensure that all attachments to the PSTN meet certain minimum requirements as far as performance is concerned to ensure that adequate transmission is achieved. There are, of course, international agreements and CCITT Recommendations which govern these performance requirements. The situation can become complex when the extension of PSTN traffic through PABXs and a network of leased lines is considered.

(*b*) *Leased Lines* Connections over leased lines are, in general, for one customer only and between two points, although there are exceptions to this. Potentially, therefore, it is entirely up to the customer to use appropriate attachments to give the desired performance. Any degradation or enhancement offered by the attachment would be suffered or enjoyed by only that customer. An example of this freedom is the use of non-standard low-bit-rate speech encoding (for example, CVSD). Such encoding, although unsuitable for extension of traffic from the PSTN, does offer leased-line customers adequate transmission performance at an economic price.

The important conclusion to be drawn from this section is that, in a deregulated environment, the performance of the network components must be clearly specified by the PTO. The customer then has the choice of which attachments to use and, in the case of leased lines, may hence determine the overall (end-to-end) performance that should be expected.

Maintainability

The maintenance of telecommunication service involves the following functions: fault reception and logging, fault location, repair, and handback of service to the customer. In the non-liberalised regime, these functions can be applied by the PTO equally for network and terminal equipment. However, where the terminal apparatus is provided or maintained by a third party (which may sometimes be the PTO), there is a need to distinguish between the maintenance of the network service and the attachment. There are a range of ways in which this may be done.

When a customer perceives a fault, the fundamental requirement is that there should be a defined procedure for clearing it. Where the location of the fault is not apparent, which is the usual case, the customer is liable to report the fault to the PTO. Since the latter may only be responsible for maintenance of the network portion of the circuit, the first task is to identify whether the fault is in an attachment or within the network. Ideally, fault location should be performed remotely to avoid the need to visit the customer's premises. If the fault is proved to be in the attachment, then either the customer or the attachment maintainer should be advised. The question of charging for the costs incurred has to be considered.

The conclusion of this discussion is that the maintenance of the telecommunication service in a liberalised environment requires a mechanism for the quick reliable location of faults to within the network or to the attachments. Furthermore the response times or fault repair times for the network service should be clearly defined. Similar levels of maintainability may be offered by the attachment maintainer. However, because of the fluidity of terminal equipment design and the large numbers of suppliers, customers may find that it is not possible always to have identical levels of maintainability from the network and the attachments. Therefore, legal possibilities and tariffs must be understood by all parties involved.

Functionality of Attachments

Where a PTO also provides and defines the attachment, the total functionality and features offered to the customer can be guaranteed, However, in the liberalised environment, terminals that meet the stipulated requirements for attachment may be used to provide the overall telecommunication service. These requirements for attachment are specified by the regulatory body in consultation with both the PTOs and the attachment manufacturers. Such specified requirements inevitably take into account the safety, performance, and functional requirements of the PTO. Additionally, attachment manufacturers need to be able to exploit the latest technology for their products. Quite understandably, attachment manufacturers require a minimum set of specifications in order to give as much freedom and flexibility as possible, and approval testing procedures which are similarly minimised to reduce cost and time taken. The outcome is that approval of attachments, which is undertaken by an independent body, while

ensuring safety and other requirements are met, does not necessarily ensure that the apparatus will actually work with the network service!

The conclusion to be drawn is that the PTO in a liberalised environment must carefully define the specific features and functions offered by the network service. Furthermore, it must be recognised by customers that suitability for their particular application, and correct overall operation, depends on their choice of attachment.

Derived Circuits

It is common practice for customers to extend their leased-line circuits. This usually takes the form of extending to point C several of the tributaries of a multiplexed link A–B (see Figure 1). The resulting circuits A–C are then known as *derived*. Points A, B and C are located on the customer's premises. In a non-liberalised environment, a PTO can predict the performance from A to C because it provides the customer-premises multiplexer located at B. However, in a liberalised environment, the PTO cannot specify the performance of the attachment at B (see under 'Functionality of Attachments', above) and therefore an overall performance of the circuits A–C cannot be offered. Rather, the PTO can offer only a defined service A–B and B–C, leaving the customer responsible, directly or indirectly, for specifying, providing, and maintaining the equipment at B and hence determining the expected overall performance.

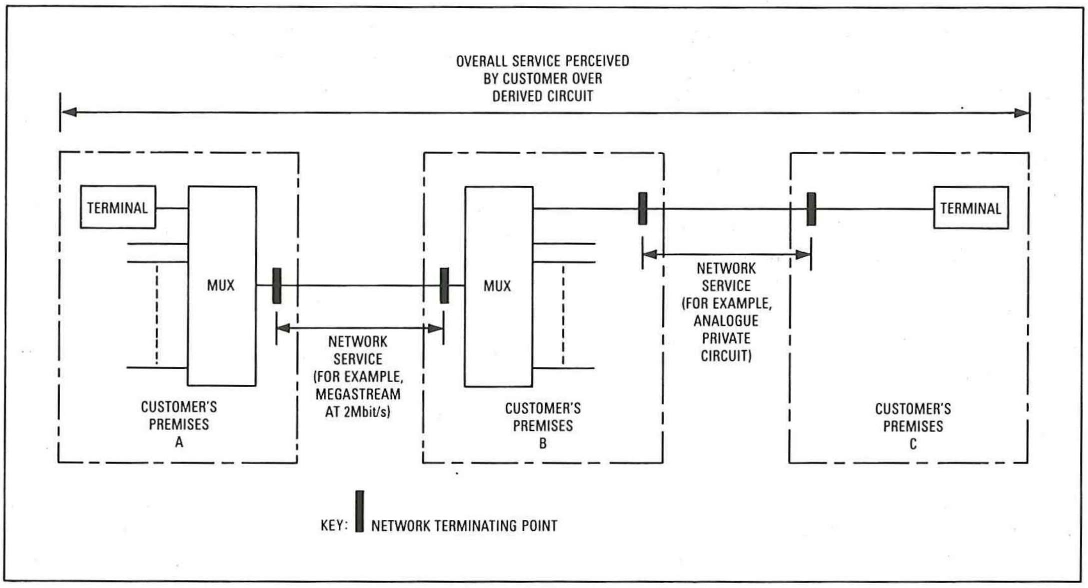
Interconnection With Other Licensed Operators

An important aspect of providing service in a liberalised regime is the need for one PTO to provide interconnection with other licensed operators (OLOs) within the country. Although this form of interconnection has similarities to international linkage between two national PTOs, there are a number of unique features associated with linking several PTOs within one country. In the mainland UK, BT is required to interconnect with MCL, Cellnet and Racal Vodafone, all of whom have the potential for national coverage, and with KHTD and the cable TV operators who have limited geographical coverage. The objective of interconnection is that calls originating in one network can successfully terminate in another network, and that callers may select which network-service operator (BT or MCL), where a choice exists. The service-related factors that determine successful interconnection are briefly described below.

Numbering

Customer connections on the networks of BT, MCL, KHTD and the cellular companies all share the UK national numbering scheme. Thus, in a liberalised regime, numbers, like the radio spectrum, are a national resource which must be fairly allocated. Where the PTO operates in a defined geographical area, one or more area (that is, national number group (NNG)) codes may be allocated to their customers. An example is KHTD, who have a unique NNG code (482). A single NNG code may also be appropriate for national services which do not require geographical significance to the numbers; for example, cellular service with national roaming. (Cellnet and Racal vodafone currently have one NNG each.) However, in the case of the second national PSTN operator, MCL, the need for geographical significance and the volumes of lines, requires either the allocation of many NNGs or the allocation of parts of the local number within each NNG. The latter has been chosen because it enables local-dialling procedures for interconnected traffic within the same local area. Thus, BT and MCL share the NNG codes for the UK, with number allocations based on D and E digits of the local number in

Figure 1
An example of derived circuits



non-director areas, and using separate AFN codes in director areas.

Routing, Charging and Accounting

In general, a call between BT and the cellular operators or KHTD is handed over at a small number of interconnection points. However, BT's and MCL's networks interconnect at numerous designated nodes; for example, BT's group switching centres (GSCs) or equivalent. Normally, calls originating on BT's network are routed through its network to the interconnection point serving the destination MCL exchange; that is, *far-end handover*. However, customers with BT exchange lines can, by subscription to MCL, invoke *near-end handover*, on a call-by-call basis, thus routing the trunk portion of a call over the MCL network, irrespective of whether it terminates on an MCL or BT exchange line. This is achieved by dialling an MCL selection and authorisation code before the national number.

Appropriate accounting systems are required to enable each of the PTOs to charge the other PTOs for handling the interconnection traffic.

Performance

(*a*) *Quality of Service* Each PTO needs to specify the target quality of service (that is, proportion of lost calls due to congestion and plant defects) for their portion of the networks so that the overall service for customers can be managed.

(*b*) *Fault Handling* Clearly, an agreed set of procedures is required if several PTOs are to collaborate in the provision of customer service. In the first instance, there must be a procedure for handling fault reports, proving the fault to one of the networks, and then advising the customer of the fault-clearance progress.

Other Facilities

Technical and contractual arrangements are needed for the provision of facilities such as access to emergency services (999), directory enquiries, operator assistance, entries in directories, etc.

PRINCIPLES

This article emphasises that, in meeting the requirements of a liberalised environment, a PTO must carefully define the performance and maintenance offerings associated with the network services it provides. This, in turn, requires a clear definition of the boundary between the network and the customer's attachment(s). The defined network service is provided across the network up to the network/attachment boundary. Some form of network terminating unit (NTU) needs to be provided on the customer's premises by the PTO in order to present the network boundary and facilitate service operation. The NTU should provide the following functions:

(*a*) *Interface to the Attachments* This interface should be to a standard, preferably international, which will endure so that customers can purchase attachments with the confidence that they have a reasonable service life. It may be necessary for a PTO to offer a choice of interfaces, depending on the availability of suitable attachments on the market.

(*b*) *Basic Network Termination* The set of functions associated with network termination may include all or some or the following:

powering of transmission terminal;
line coding/signal modulation/scrambling;
link monitoring;
2-to-4 wire conversion;
higher-order multiplexing.

(*c*) *Network Testing* This function enables the circuit to be broken close to the network boundary so that faults can be proved to the network or the attachment. Once broken, the circuit may be looped, under local or remote control, to enable test signals to be returned. In addition, circuits may be diverted to a test facility. Ideally, looping and testing should be activated and controlled remotely so that the need for unnecessary visits to customer's premises by the PTO's staff is minimised.

(*d*) *Safety Barrier* Some level of safety isolation needs to be provided by the NTU, especially if mains power is involved.

The functions described in (*b*) and (*c*) above are defined in the UK at the network termination and testing point (NTTP) and provided by network termination and testing apparatus (NTTA). The NTU therefore incorporates the NTTA. It is important that the PTO incorporates an adequate NTTA on the customer's premises in order for well-defined services to be provided. The concepts of the network service, network termination, and overall service including the attachments are now included in the CCITT Recommendations (Blue Book) on ISDN. These describe the concept of bearer service and teleservice (Recommendation I.210) and the functionality that needs to be provided at the network termination (Recommendation I.411).

BT EXPERIENCE

The effects of deregulation on the provision of telecommunication services described in this article are based on BT's experience. There is no doubt that, in the wake of deregulation potentially immense business can be created in the attachment area. The marriage of processing and telecommunications sets to produce an ever-increasing range of attachments, and there is no sign that this surge will abate in the foreseeable future.

On the practical side, to cope with deregulation, arrangements have to be made to handle the attachments business efficiently. In the UK, this has necessitated updating British standards

to specify current requirements for connection of apparatus to PTO circuits and the establishment of an organisation, the British Approvals Board for Telecommunications (BABT), to ensure compliance with these requirements so that government approval for attachment may be given. With the growth of business in this area, the organisation and procedures entailed have to be such as to avoid unnecessarily-long approval delays and to provide effective arrangements for retest where necessary.

On the network side, the KiloStream service, which offers digital leased lines, gives an example of the service definition provided by BT. KiloStream provides a digital path up to 64 kbit/s between two customer premises. The network termination is housed in an NTU which offers standard X.21 and X.21*bis* customer-attachment interfaces. The NTU provides the transmission termination of the digital link into the network, including the enveloping of the customer's data. Maintenance loops can be applied locally by the customer or remotely by BT from appropriate management centres (for example, XSCs). The service is defined between NTUs in terms of error and availability performance, and after-sales support in terms of time to repair faults. BT has learnt the need to be specific about these parameters because of the wide range of attachments now being used with KiloStream over which BT has no control. An important lesson is that customers must be made aware of the limits of the network service offering in order to pre-empt inappropriate expectations on the resulting overall service.

OPEN NETWORK PROVISION

Many of the features of providing telecommunications services in a deregulated environment will be enshrined in the mandatory EEC requirements of open network provision (ONP), to be operative from 1992. ONP will require PTOs in the member states to provide a set of services and features that adhere to standard technical specifications for customer–network interfaces, standard service parameters (for example, provision and repair times), and tariff principles.

FINAL THOUGHT

The presence of competition in the operation of network service, and deregulation in the attachment market, creates a stimulating environment with benefits for a PTO and its customers. Provided clear guidelines are established and effective preparations made, such an environment should be welcomed by telecommunications administrations.

Biography

Andy Valdar joined the Network Planning Department of the British Post Office (now British Telecom) in 1969. His work included developing the implementation for BT's digital network and its synchronisation. In 1977, he undertook a 3-year assignment with the ITU in India working as a senior expert in switching systems at the Advanced Level Telecom Training Centre, Ghaziabad. Since returning to the UK, he has worked on ISDN standards, representing BT at CCITT and CEPT forums. More recently, he has been responsible for digital private-circuit marketing, strategy and planning, and product management of Centrex. He is currently General Manager, Network Strategy in BT Headquarters. He has a bachelor's degree in Electrical and Electronic Engineering from Loughborough University and an M.Sc. degree in Telecommunications Systems from Essex University, and is a member of the Institution of Electrical Engineers.

AXE10: Architecture

R. B. SILVERSON†, and J. BANCROFT*

British Telecom has placed a contract with Ericsson Limited for the development of the AXE10 digital switching system for the BT network, and for the supply of a quantity of exchanges. In this article, the first of a series on AXE10, the authors provide an overview of the AXE10 system architecture and its functional structure, describe the individual subsystem functions and conclude with a note on system reliability.

INTRODUCTION

In March 1985, after a detailed evaluation of digital switching systems, BT placed a contract with Ericsson Limited for the development of AXE10 for the BT network and for the supply of a quantity of exchanges.

AXE10 is a duplicated-processor stored-program controlled digital switching system designed by Telefon AB LM Ericsson of Sweden. The system is structured for local, tandem, transit and combined exchange applications. It can also be configured as a cellular mobile or as an international switching centre.

SWITCHING ARCHITECTURE

The system architecture is logically divided into two main parts, the switching system (APT) and the control system (APZ). See Figure 1.

The switching system (APT) performs traffic and operation/maintenance functions. It comprises four main hardware subsystems:

Subscriber switching subsystem (SSS)
Group switching subsystem (GSS)
Trunk and signalling subsystem (TSS)
Common-channel signalling subsystem (CCS)

and the following software subsystems:

Traffic control subsystems (TCS)
Charging subsystem (CHS)
Operation and maintenance subsystem (OMS)
Subscriber services subsystem (SUS)
Network management subsystem (NMS)

All hardware subsystems have a software component.

The control system (APZ) is made up of central and distributed logic achieved through the following subsystems:

Central processor subsystem (CPS)
Regional processor subsystem (RPS)
Maintenance subsystem (MAS)
Support processor subsystem (SPS)

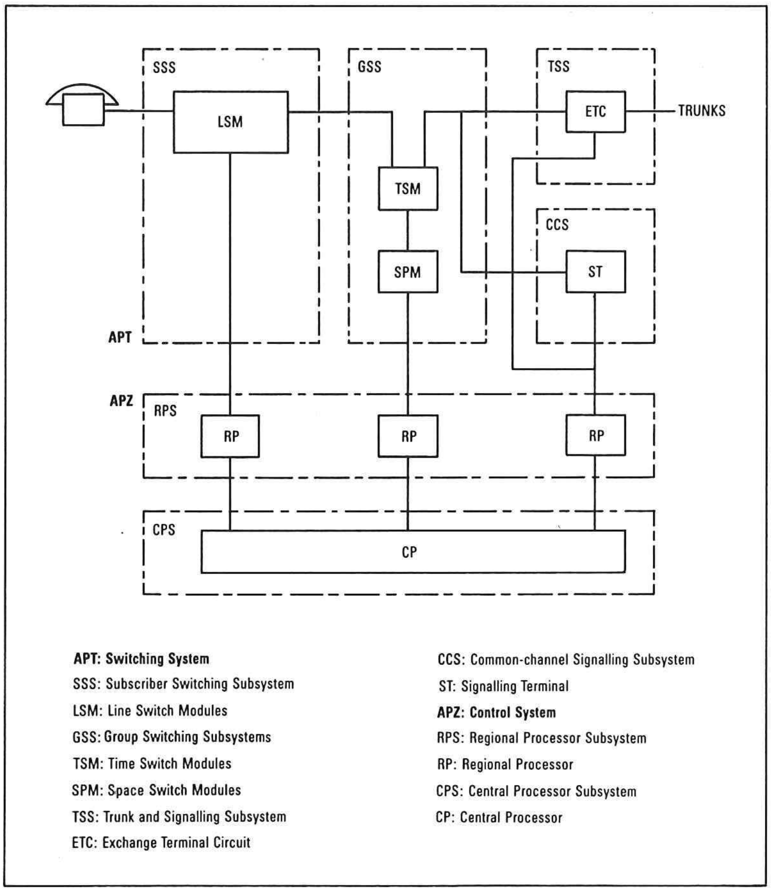


Figure 1
Hardware structure of the AXE10 system

Data communication subsystem (DCS)
File management subsystem (FMS)
Man–machine communications subsystem (MCS)

In earlier exchanges the input/output subsystem was used instead of SPS, FMS, MCS and DCS.

See Figure 2 for the subsystem structure.

FUNCTIONAL STRUCTURE

The division of the systems (APT and APZ) into subsystems is determined by conditions and requirements that arise from features, traffic handling and operations and maintenance functions. See Figure 3.

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* Ericsson Limited

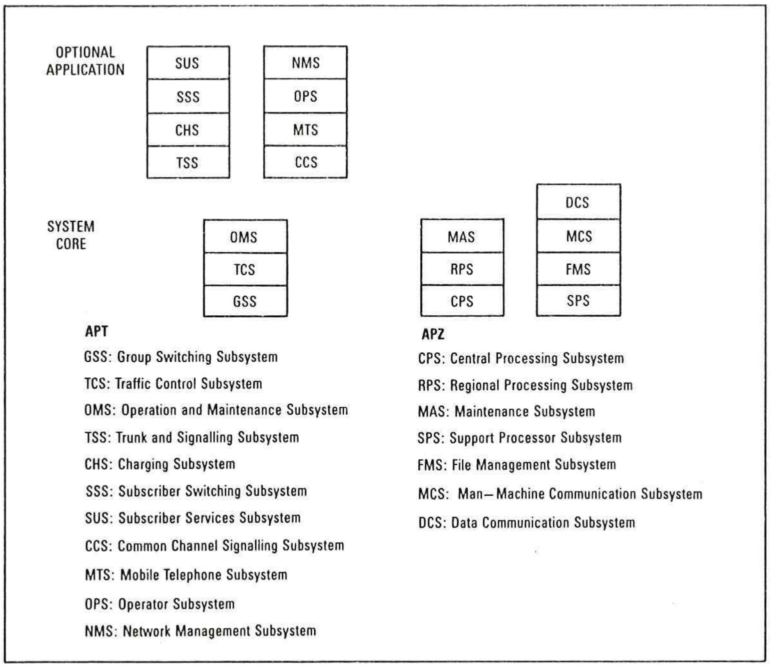


Figure 2—AXE10 subsystem structure

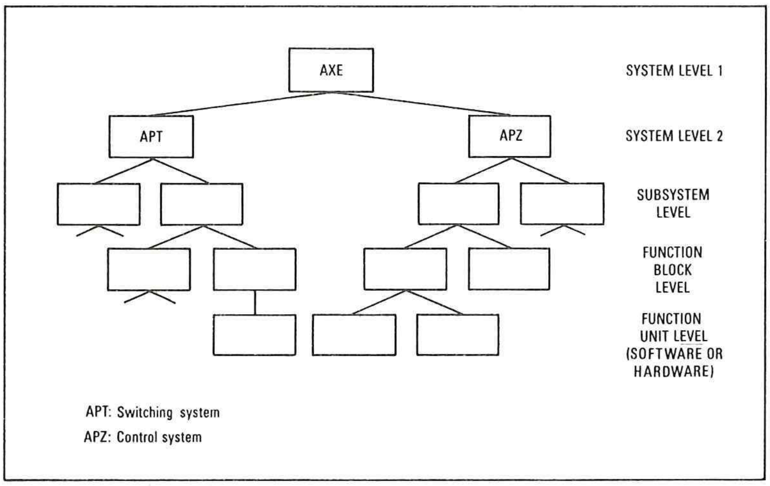


Figure 3—Functional levels in the AXE10 system

The subsystems, including their interfaces, are designed such that they can be used for different applications with the minimum of adaptation.

Each subsystem is built from a number of function blocks which in themselves comprise hardware, central software, regional software and data components, or just central software and data components. Each function block is designed to execute a specific set of functions or sub-functions. A library of several hundred functional blocks exists to satisfy all applications and individual exchange requirements. Standardised interface signalling is extensively used between blocks not only to achieve the necessary flexibility to satisfy customers' requirements, but to also enable new technology to be introduced within the system in an efficient manner. See Figure 4.

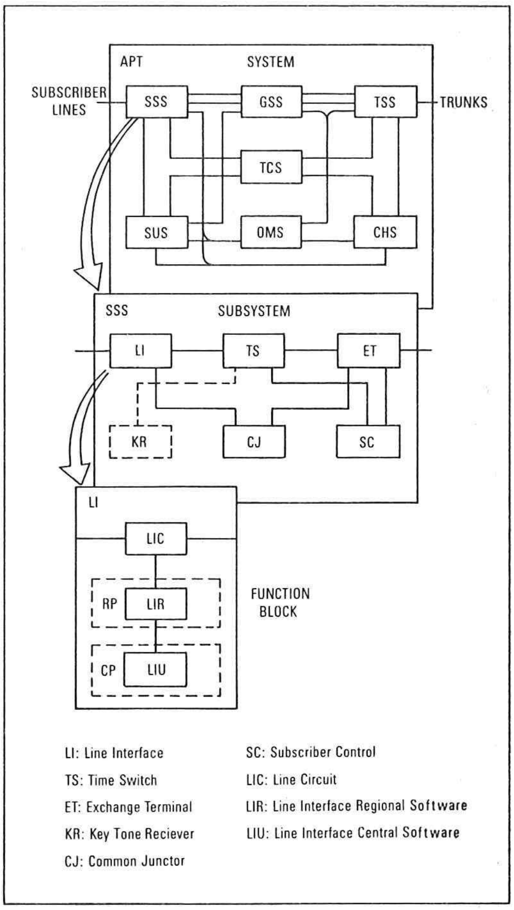


Figure 4—Functional structure of APT

To meet the twin needs of high capacity and low cost, the complex executive tasks necessary to operate the system are executed by the duplicated central processor (CP) working in a parallel synchronous mode. The routine, high volume tasks, such as scanning operations and for the direct control of hardware, are distributed across a dimensionable number of small regional processors (RPs). Regional processors controlling several hardware units are configured in a load sharing mode. The software driving the APT functions, therefore, has both APT and APZ elements.

THE APT SUBSYSTEMS

Subscriber Switching Subsystem (SSS)

The subscriber switching subsystem contains the digital subscriber switch and is built up of 16 line switch modules (LSMs). An LSM serves 128 analogue subscribers or can support four 30-channel systems for ISDN customers. Its principal function is to supervise the state of connected subscriber lines, and to set up and release connections by sending and receiving signals to and from subscribers. The SSS comprises both hardware and software. To allow for the possibility of reducing line-plant costs, the local exchange may be engineered with distributed switching in the form of a remote subscribers switch (RSS).

Trunk and Signalling Subsystem (TSS)

The trunk and signalling subsystem includes the equipment for connecting trunks to the group switch. It supervises the state of trunks to other exchanges by means of the signals it receives and sends. The TSS consists of both hardware and software.

Group Switching Subsystem (GSS)

The group switching subsystem houses a time-space-time digital switch built up of duplicated time switch modules (TSMs) and duplicated space switch modules (SPMs). Its primary purpose is to set up a 64 kbit/s path between SSS and TSS devices through the group switching network. It is also responsible for network synchronisation functions. The GSS comprises hardware and software.

Traffic Control Subsystem (TCS)

The traffic control subsystem is wholly software, and controls and supervises the set-up and release of connections. The TCS stores and analyses digit information received from the SSS and TSS, and then, after checking against previously recorded information, for example, subscriber categories, routing and tariff classes, decides how the call should be handled.

Charging Subsystem (CHS)

The charging subsystem consists of central software blocks and is responsible for the task of charging calls by means of very accurate pulse metering techniques. In addition to normal charging, special subscribers charging facilities are available such as itemisation and advice duration and charge (AD&C) information. The CHS also provides the administration with charging statistics and per-event charging information. It functions by monitoring and then analysing call information from the TCS or SUS (for service information). Output to the FMS follows execution of the charging function.

Operation and Maintenance Subsystem (OMS)

The operation and maintenance subsystem mainly comprises software blocks. Its function is one of system supervision, fault location, collection of statistics and for dealing with the administration's operation and maintenance functions. It can be operated either in the local or in remote mode, say from a remote operation and maintenance centre.

Subscriber Services Subsystem (SUS)

The subscriber services system consists entirely of central software. Its function blocks provide a variety of subscriber services. Typical SUS services include:

Abbreviated dialling
Three-party services (enquiry, hold and transfer)
Diversion (immediate, on busy and on no-reply)
Malicious call trace
Call barring
Automatic alarm call

Common-Channel Signalling Subsystem (CCS)

The common-channel signalling subsystem implements the message transfer part (MTP) of CCITT Signalling Systems No. 6 and No. 7. The subsystem consists of hardware and software blocks, the hardware devices (signalling terminals) being connected to the external signalling links via a semi-permanent connection through the group switch.

Network Management Subsystem (NMS)

The functions of the network management subsystem are implemented in software. The role of NMS is to provide access via the normal input/output devices for the administration to monitor continuously the state of the network.

THE APZ SUBSYSTEMS

Central Processor Subsystem (CPS)

The central processor subsystem is realised in both hardware and software. The CPS executes the complex software tasks which are stored in the various APT blocks. The main hardware parts of the central processor, which is duplicated and runs in the synchronous mode, are the central processing unit (CPU) and the memory stores. These stores comprise the main store (MS) or program store (PS), reference store (RS) and the data store (DS).

The purpose of the CPS is to execute the following functions:

- Program control including supervision of functions and for measuring processor load.
- Loading and storage of tasks.
- Output and updating reloading information.
- Controlling fault tracing programs resident in the MAS or RPs.

Regional Processor Subsystem (RPS)

The regional processor subsystem consists of both hardware and software blocks. The purpose of the RPS is to run the simple, routine and very frequent tasks to drive the RP part of the APT software and hardware. The number of functions performed by an RP pair depends upon the complexity of these functions. The number of RP pairs required for a given exchange depends upon its size and the complexity of its signalling systems.

Maintenance Subsystem (MAS)

The maintenance subsystem consists of both hardware and software. The major role is to supervise the operation of the APZ control system and takes the appropriate action should a malfunction occur.

Support Processor Subsystem (SPS)

The support processor subsystem consists of one or more independent processors which drive input/output equipment such as personal computers, visual display units and disc drives which are connected to the subsystem.

Data Communications System (DCS)

The software for the data communications system resides in the SPS. It also has a hardware element to support protocols such as X.25. Its function is to support remote operation and maintenance, and transfer of itemised call accounting data.

File Management Subsystem (FMS)

The file management subsystem consists wholly of software. It provides storage in the event that a data link failure occurs.

Man–Machine Communications Subsystem (MCS)

The man–machine communications subsystem consists of software. It provides security checking and authorises I/O devices and the operator for a particular function. It routes data output from the exchange to the preselected terminal(s). In addition, the MCS controls the generation of alarm printouts or displays.

RELIABILITY

System performance is determined by both hardware and software reliability.

Hardware reliability is achieved by choice of components and by duplication of units which perform a task affecting a proportion of the exchange function.

Software reliability exists through system recovery functions which rely on three restart levels namely:

- *Small Restart* The APZ clears all jobs in process of being established. The status of all existing calls is maintained.
- *Large Restart* If the small restart is rapidly followed by a new software error then a more extensive restart involving a reset of all dynamic data will take place. All existing calls are cleared.
- *Restart with Reload* The highest level of restart is enacted when the large restart fails to lead to a successful program execution. The system then automatically reloads programs and data from an external store. All existing calls are cleared.

Biography

Roy Silverson was the team leader responsible for the technical evaluation for the System Y project. Upon contract placement with Ericsson in March 1985, he was appointed as the BT project manager for the AXE10 project. Previously, he worked as a technical expert on BT crossbar systems and for a short period as a consultant for Bahamas Telephone Company. Roy is currently working as a staff and organisational development manager within Network System Engineering and Technology Department.

John Bancroft, after a lengthy period with Plessey Telecommunications which saw the transition from Strowger through to System X, in November 1985 joined Ericsson as a Principal Engineer in the Technical Planning Department to work with the BT local System Y project. He is now the Product Management Department Manager in the Public Systems Division based in Brighton, being responsible for AXE10 requirements towards the software design sector of Ericsson and towards BT.

Centralised Exchange Management Using Gateway Products

G. NEILSON†

This article briefly describes the Gateway products used for centralised exchange management in the analogue network. It describes their facilities and architecture and gives a note on system penetration. The article goes on to describe enhancements that are currently under development. The article is based on the author's paper for the 28th European Telecommunications Congress held in Lisbon, Portugal, from 3–9 September this year. The author was presented with a prize for his paper.

INTRODUCTION

The modernisation programme, within British Telecom, has reached an advanced stage, and as such we have gained benefits from digital switching and transmission.

We have also realised the need to manage a modern digital network and how those remote management principles can be applied to the many aspects of the analogue network. This article sets out to explain the technology that underpins centralised management of the analogue network.

The usefulness of centralised management was immediately evident and it became obvious that these facilities should be offered to the analogue network, hence enabling one centre to manage all exchange types used within its boundary.

GATEWAY PRODUCTS

Gateway is the generic name for a family of microprocessor-based systems used in British Telecom for remote line testing, secure database access and exchange management.

The Gateway products employed for the exchange management function are:

(*a*) Gateway remote exchange management (REM) remote units (one version of which is known as *REMPlus*)—installed in the telephone exchanges (one per exchange);

(*b*) Gateway alarm reporting unit (ARU)—installed in the centre (one per 80 remote units);

(*c*) Gateway alarm display personal computer (PC)—installed in the centre (one per four ARUs);

(*d*) Gateway interactive PC—installed in the centre (one per centre)

FACILITIES

REMPlus

The main features of the Gateway REMPlus are:

- remote target access (V.24),
- up to 127 configurable alarm inputs,
- eight remotely controlled channels,
- hourly confidence calls (to ensure system integrity),
- dual alarm reporting (for example, day and 24 hour sites),
- exchange battery test (−50 V supply tested against high and low user-set thresholds).

Alarm Reporting Unit (ARU)

The Gateway ARU is responsible for managing the communications between the alarm display PC and the various Gateway remote units.

Alarm Display PC

The alarm display PC gives a graphic real-time display of the alarm state of up to 320 exchanges. It gives the user the following facilities:

(*a*) out-of-hours operation controlled by one man—monitoring up to 320 sites;

(*b*) a clearly defined display—detailing the state of each site;

(*c*) an historical record of every transaction;

(*d*) true day and 24 hour working;

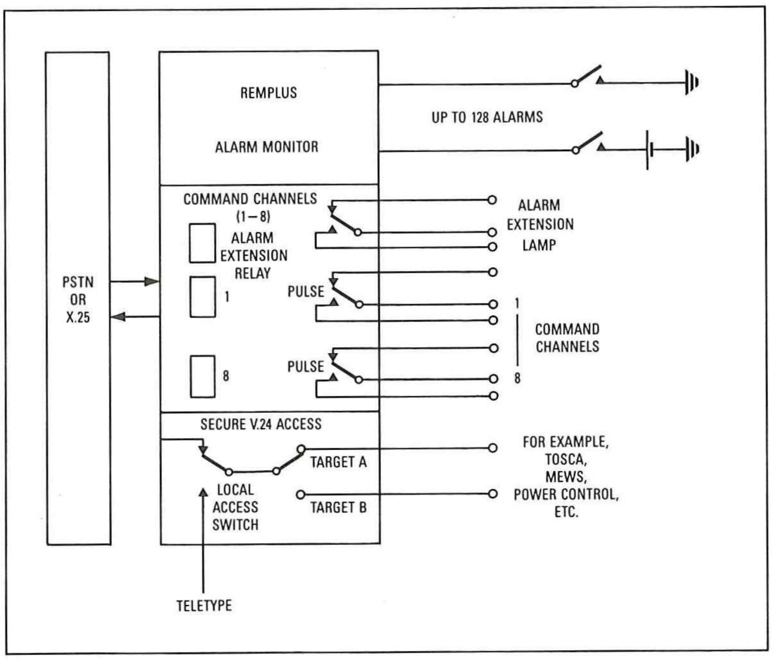


Figure 1
Gateway REMplus schematic

† East of Scotland District, British Telecom UK

(*e*) master/slave working, that is, the ability to transmit to a slave system;

(*f*) use of a character set to annotate the screen to show that a call-out has occurred; and

(*g*) the ability to translate each incoming alarm message, hence giving user flexibility.

Interactive PC

The interactive PC enables a number of frequently used exchange man–machine interface (MMI) commands to be driven from a menu-based system, namely:

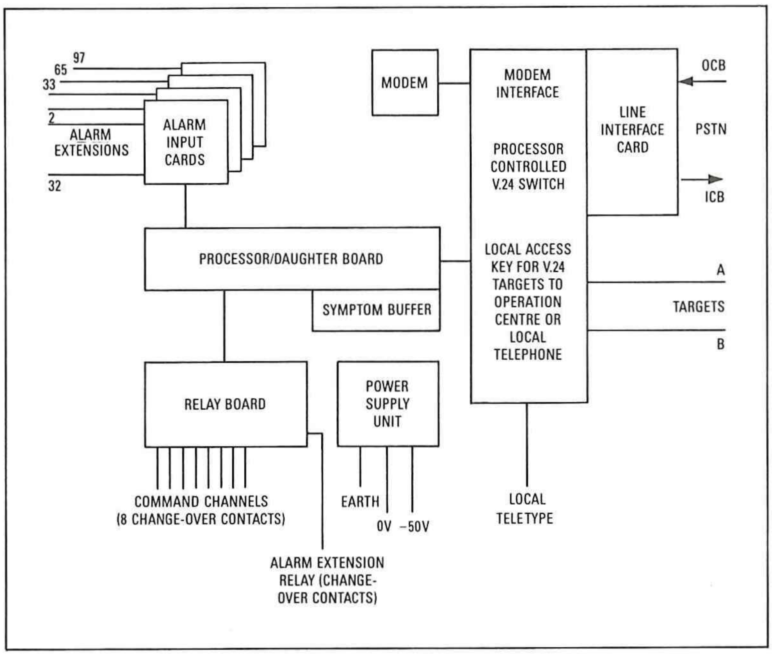


Figure 2—Gateway REMplus unit

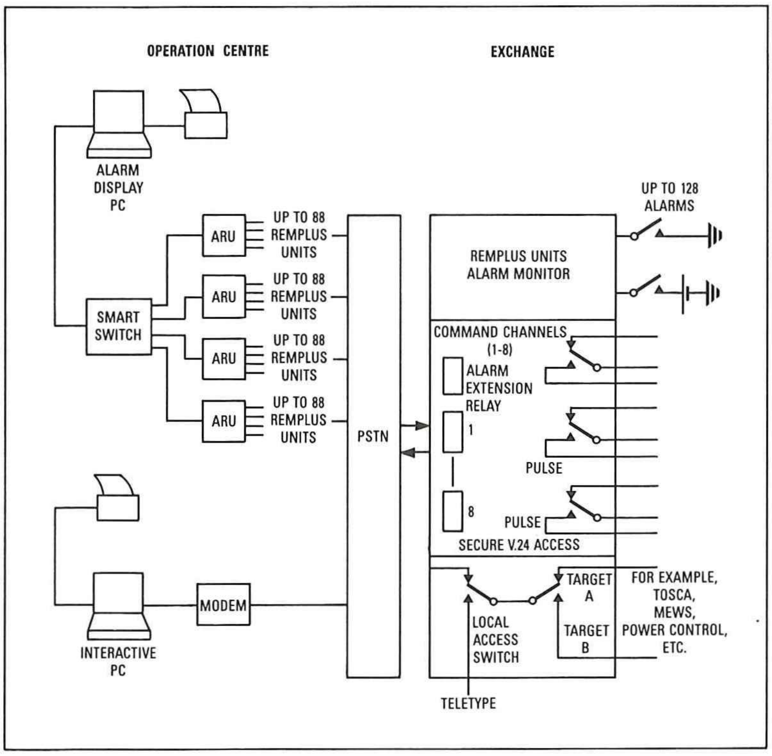


Figure 3—Connection of operational centre and Gateway remote units

(*a*) automatic temporary out of service (TOS)—taking customers' lines out of service, either immediately or from a programmed diary;

(*b*) automatic restoration of service (ROS)—restoring service to customers' lines, either immediately or from a programmed diary;

(*c*) automatic meter readings (both traffic and customers');

(*d*) reading/altering customers' attributes; and

(*e*) routine testing of the alarm system.

It should be noted that the first four points detailed above are exchange dependent and to date the system will correctly operate with the following exchange types:

(*a*) TXE4A—no meter reading;

(*b*) TXE2 (with TOSCA† fitted)—no meter reading;

(*c*) UXD5A—no meter reading; and

(*d*) UXD5B—full facilities.

SYSTEM ARCHITECTURE

Figure 1 is a block layout detailing the facilities provided by the Gateway REMPlus unit.

When a site is unmanned, the exchange alarms are extended to a remote central location. The Gateway REMPlus unit, detailed in Figure 2, can provide this alarm-reporting facility via the public switched telephone network (PSTN). It also provides remote switching channels and secure access to two V.24 ports. Each remote switching channel can provide an output pulse which may be used for a variety of functions, such as alarm resets or equipment changeover. The V.24 ports may be used for various control and monitoring functions.

Figure 3 details the operation centre and its connection with the Gateway remote units. Gateway REMPlus has been used in the example, although other variants such as Gateway H, REM or G could have been used equally successfully.

SYSTEM PENETRATION

Figure 4 details the penetration of Gateway alarm systems within British Telecom UK.

In the East of Scotland District, the main Gateway alarm system used is known as *Gateway H*. Figure 5 details the penetration of Gateway H hardware within the District and the amount of hardware employed. The Gateway H system also provides remote line test facilities.

ENHANCEMENT

In the future, the individual PCs used at the central site will be linked by use of a new device, known as *alarm collection facility* (ACF), which is currently under development.

† TOSCA refers to computerised equipment controlling customers' class of service

This development is based on the M6000 family of BT products running under the UNIX operating system. The development will provide the following features:

(*a*) one reporting point for 24 hour alarm management;
(*b*) automatic alarm distribution;
(*c*) automatic alarm reset;
(*d*) history database of alarms and interactive tasks (that is, resets);
(*e*) full management statistics;
(*f*) automatic alarm transfer;
(*g*) full alarm translation facilities;
(*h*) full system security; and
(*i*) flexible alarm categorisation.

Figure 6 shows the program sequence of the ACF system.

One Reporting Point for 24 hours Alarm Management

One control point for 24 hour alarm management has proved to be the most cost-effective method of controlling exchange alarms. With this system, the alarms are concentrated and redistributed automatically as each alarm destination either logs off or on to the system. During the night, it also provides one location with a complete picture of all alarms under its control.

Automatic Alarm Distribution

The automatic alarm distribution facility is controlled from within the ACF by an 'intelligent' program which monitors the 32 possible alarm destinations, and passes the alarm to the highest priority 'logged-on' destination. Each alarm may have up to four possible destinations stored against it in the database.

Automatic Alarm Reset

The provision of the facility enables the ACF to attempt a predetermined number of automatic reset operations within a set timescale. After this time has elapsed, the alarm will either be displayed as normal or, if the resets were unsuccessful, then the alarm will not be displayed but simply stored as a statistic for future interpretation and investigation.

History Database of Alarms and Interactive Tasks

A complete time and date history of each reported alarm will be contained within the ACF database. This permits a complete analysis of all alarms reported to the ACF, even where these alarms were automatically reset by the system. The detail of the analysis is controlled by user requirements and is only limited by the number of permutations available within the database.

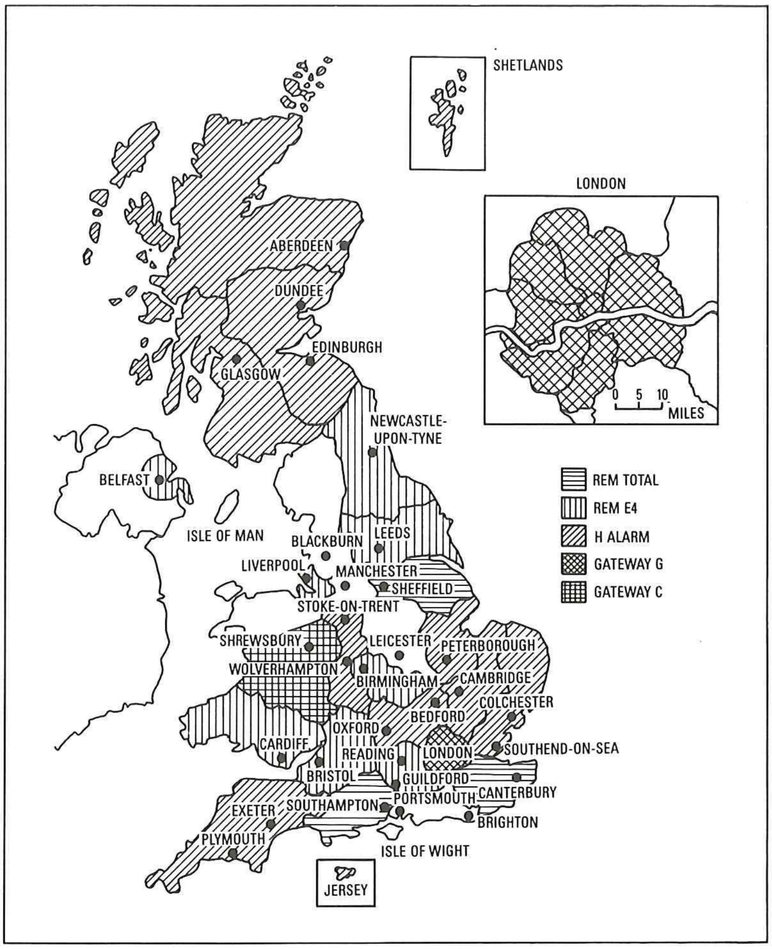


Figure 4—Penetration of Gateway alarm systems in BT

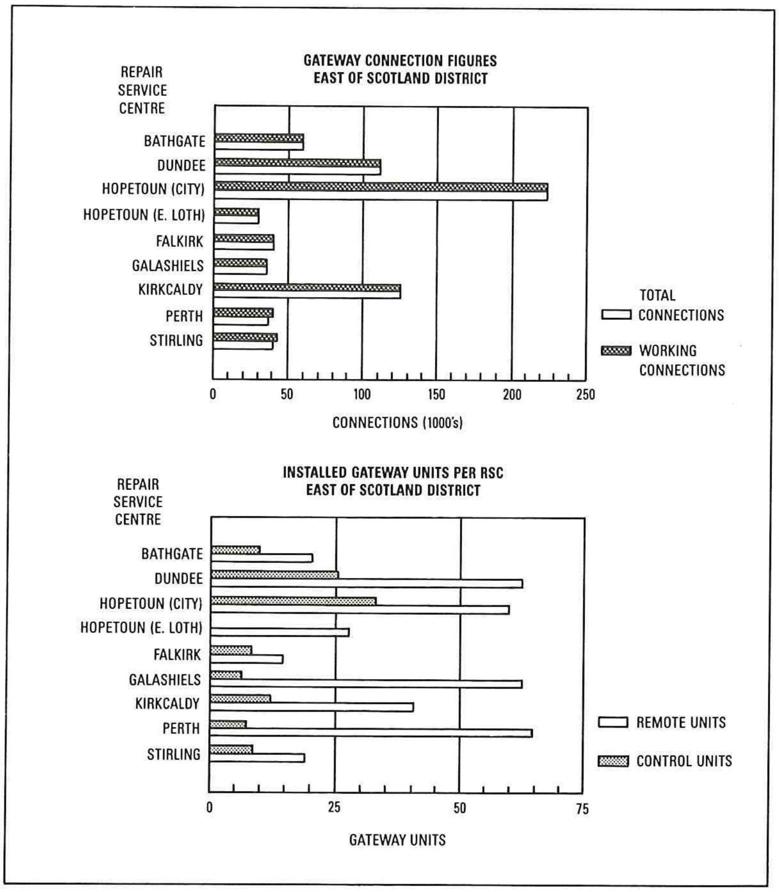


Figure 5—Pentration of Gateway H in East of Scotland District

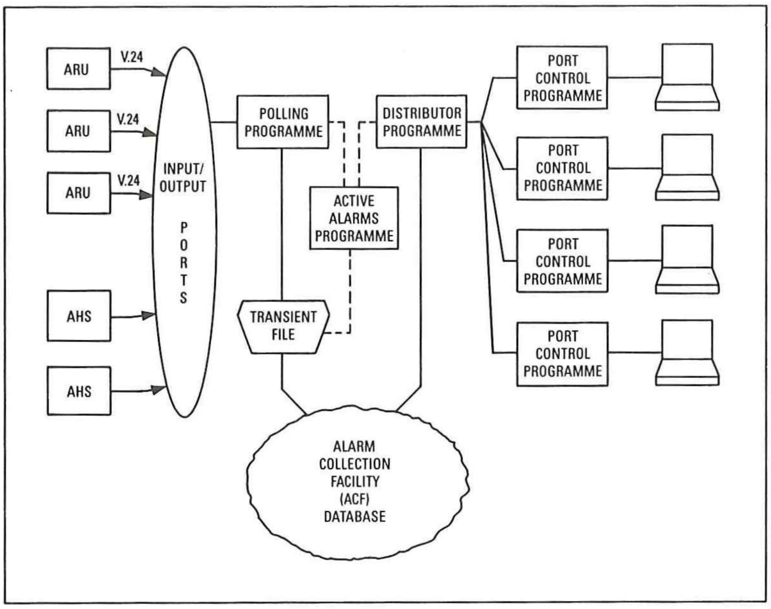


Figure 6—ACF program sequence

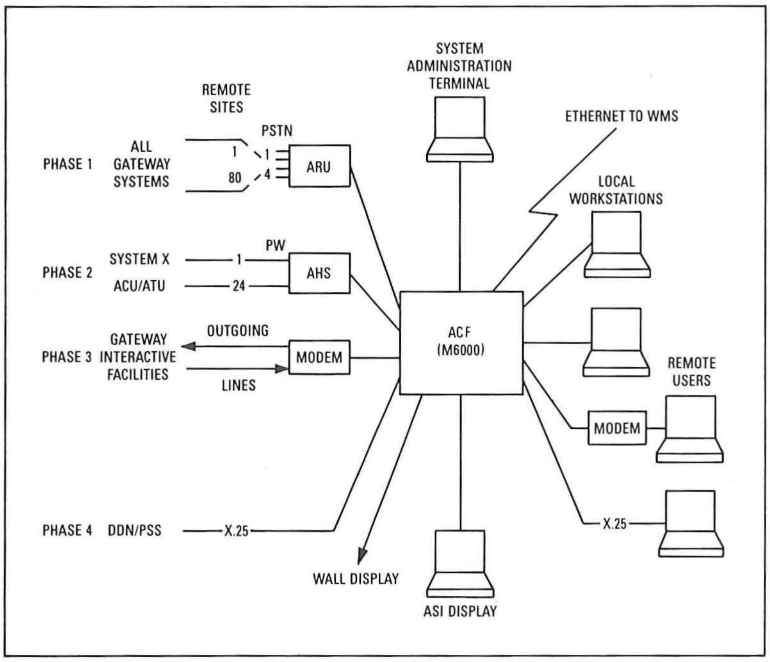


Figure 7—ACF system development

Full Management Statistics

Whenever an alarm is reported to the ACF, a record of the date, time and duration is logged. The last six occurrences of any alarm may be displayed immediately, although the previous records will be transferred to a master file for future analysis.

Automatic Alarm Transfer

As previously described, the destination of an individual alarm is determined by the ACF against the four prioritised destinations held in the database against each alarm. The automatic alarm-transfer facility enables each destination to 'log-in' or 'log-out' from the system without loss of alarm visibility as the system will redistribute the active alarms to cater for the modified availability of destinations.

Full Alarm-Translation Facility

This facility will enable the user to change the title of any incoming alarm thus providing total flexibility in the configuration of the system.

Full System Security

Access security is controlled within the ACF by a combination of names and passwords, permitting various levels of control and access throughout the system.

Flexible Alarm Categorisation

Each alarm will be assigned one of five priority categorisations within the ACF database and will therefore be either distributed to one of the 'logged-on' destinations or stored within the ACF. The level of priority which may be displayed will be alterable from the individual terminal destinations. However, a printout detailing all retained alarms will be produced daily. This is an essential feature of disaster management.

Figure 7 shows a block diagram layout of the ACF system after completion of its four stages of development.

CONCLUSION

Gateway enables centralisation of manpower and the removal of low skill tasks, such as TOS etc., as these tasks will be implemented directly by the accounts group using Gateway hardware. The categorisation of exchange alarms facilitates centralised management of the exchange and has shown a resultant decrease in call-out attendances. These changes have been well received by the technical field staff as they are freed from most of the mundane tasks and their time can be spent more effectively on detailed technical investigations more allied to their training.

Biography

Graham Neilson is currently a member of the Gateway national support group based in East of Scotland District. He joined British Telecom as an apprentice in 1969 and for much of his early career was involved with Strowger exchange maintenance. He was promoted to Level 1 in the Scottish regional headquarters and was involved with the technical support and documentation of UXD5 exchanges. His current duties include customer and sales support for the Gateway family of products and the production of user documentation.

X.400 Electronic Mail

C. F. WILKINSON†

There are probably more than a hundred electronic mail systems in the world today. Very few of these systems can intercommunicate because they do not conform to any agreed standard. This article describes an international standard which has been defined in an attempt to overcome this problem. It also describes new British Telecom products which conform to this standard.

INTRODUCTION

Electronic mail systems have been around for many years now. The first, and arguably still the most popular, is Telex, based on a dedicated network, originally working at a speed of 50 baud, although this can now be improved upon, and with an extremely limited character set. Facsimile (Fax) is another, rather different, form of electronic mail, but it has significant limitations (see later).

With the introduction of computers and data transmission over the public switched telephone network (PSTN) on a large scale, many people saw the opportunity to provide faster cheaper mail systems with many more facilities. Probably the best known of such systems today, providing a public service in the United Kingdom, is Telecom Gold, and there are others such as One-to-One; world-wide, there are many more.

Computer manufacturers also provide mail systems for their customers, generally as part of an integrated office automation (OA) system. Examples of these are IBM's PROFS and DISOSS products, and DEC's All-in-One.

THE TOWER OF BABEL SYNDROME

The situation is that there are several different electronic mail systems, each of which can send messages quite well within the one computer or between like computers running the same software, but which is completely incompatible with any of the other systems (Figure 1).

It is relevant to ask why this should be so since most computers handle text in the form known as *American Standard Code for Information Interchange* (ASCII) and the data transmission between the machines conforms to international standards. It is true that ASCII is common to most computers, except IBM mainframes that use extended binary coded decimal information code (EBCDIC), and most computers can be connected to the PSTN by asynchronous or synchronous modems or to Packet SwitchStream (PSS) for packet transmission, but here the level of standardisation ends.

Take, for instance, the name and address of the intended recipient. One system may use a cryptic *73:TBP274*, another may use *J. Soap/Computer Services/BT/Great Britain* and a third *Great Britain:BT:Computer Services:J. Soap*. Without a complex translation between systems, there will be no chance of successfully sending a message between them. And this is only one example. There are some tens of attributes that must be be standardised to enable fully functional mail systems to transmit mail to one another.

THE BIRTH OF X.400

The standardisation problem just described was recognised in the early-1980s. It was put before the International Telegraph and Telephone Consultative Committee (CCITT), and members of the relevant committees set to work to produce a standard for electronic mail which became known as *X.400*. This standard was ratified by the CCITT plenary in 1984, hence reference to

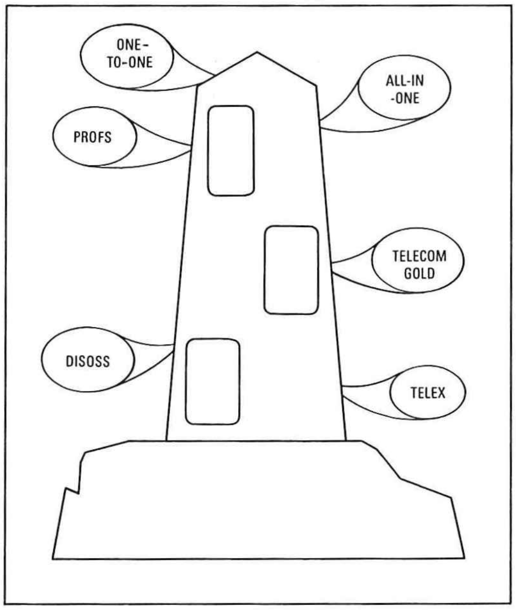
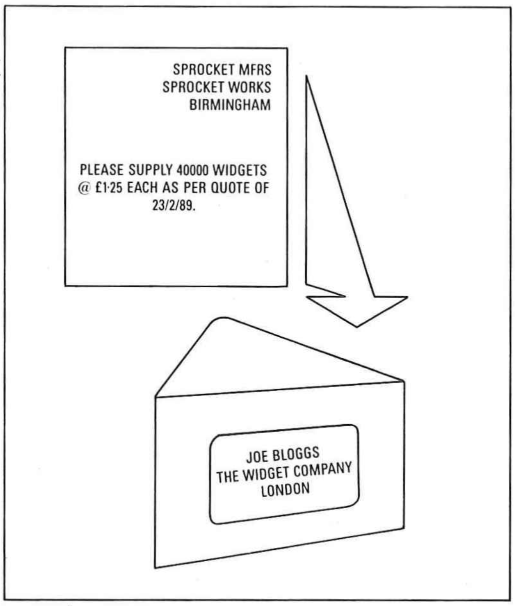


Figure 1
Tower of Babel

† British Telecom Communications Systems Division

Figure 2
X.400



X.400 (84). An updated version was ratified in the following plenary in 1988, known as *X.400 (88)*; this is examined later.

The International Standards Organisation (ISO) was a little later into the field of electronic messaging. It is to be welcomed that the ISO has agreed to ratify a common standard. There are one or two, mainly cosmetic, changes including the name: ISO calls the standard *message oriented text interchange systems* (MOTIS).

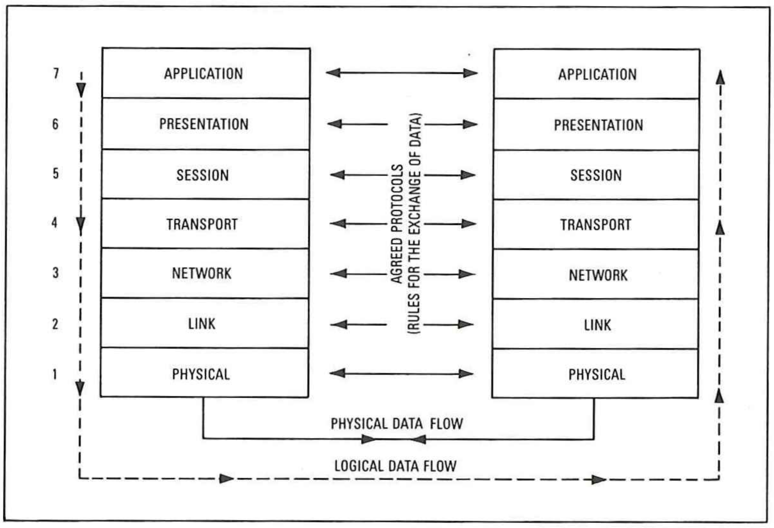
The standard defines what documents can make up a message, the format of the 'envelope' that is put round the message and the way the envelope is transmitted to its destination(s) (Figure 2).

THE PLACE OF THE PROFILE

While an international standard for electronic mail now exists, the standard cannot, unfortunately, be implemented by anyone with any assurance that their implementation will interwork with any other.

The problem arises because the standard is somewhat 'coarse' in places. It may, for instance, define a name as being from 0–512 characters long. This may not be sensible for a practical implementation. In particular, 0 characters may cause problems. Another example, is where the standard gives a number of options for implementing a facility, none of which can interwork with any other.

Figure 3
OSI model



The solution adopted is to define a *profile*. This is, in effect, a standard within a standard. It would, in the example above, narrow the options on the name field by specifying that the field had to be 32 characters long and could contain a name of from 1–32 characters. The optional ways of implementing a facility would be reduced to one. Examples of profiles are BT's Open Network Architecture (ONA) and the Government OSI Profile (GOSIP). OSI stands for *Open Systems Interconnection* and is another ISO standard.

OPEN SYSTEMS INTERCONNECTION (OSI)

OSI defines a generalised model of communications networks, and the application running over them, that is structured and layered in such a way that practical implementations of any particular layer can interwork with other implementations of adjacent layers. This is achieved by defining the functionality of each layer and its interfaces to adjacent layers.

The model consists of seven layers as shown in Figure 3. Data passes from an application in one stack, down through the layers, across the physical link and up through the layers on the other stack to the other application. The corresponding layers in each stack define an 'agreed policy' or protocol between them for handling the data at their level. Each layer is now examined in turn.

1. Physical

The Physical layer defines the actual physical connection over which the data is transmitted; for instance, the type of coaxial cable used by thin-wire Ethernet, and the voltage levels and timings of the data bits etc. Here it is clear to see what is meant by an agreed policy. If the equipment at one end of the connection was engineered for coaxial cable with a 10 MHz signal and the other was engineered for twisted pair with a 500 kHz signal, it is unlikely that any communication would take place between them.

2. Link

The Link layer defines the way in which bits sent over the Physical layer between the two ends of the wire are handled as far as such things as error checking are concerned.

3. Network

The Network layer defines the way in which individual links are connected together to form

a circuit between two end points. If the system contains only point-to-point links as, for example, some local area networks (LANs) do, this layer will have very little in it.

4. Transport

The Transport layer defines the control and error handling between the two ends of the circuit. There are five subdivisions, known as *classes*, within the Transport layer ranging from Class 0, with little error correction, for circuits with extensive error control at the lower layers, to Class 4 with extensive error correction for circuits that are inherently error prone or have little error checking at the lower layers.

5. Session

The Session layer defines the necessary protocol to enable the computers at the two ends to establish a call. This includes such things as how the computers log on to each other.

6. Presentation

The Presentation layer defines how data items are handled within a session. For instance, it may define that calendar dates are represented as YYYY/MM/DD and that times are represented as HH:MM:SS.

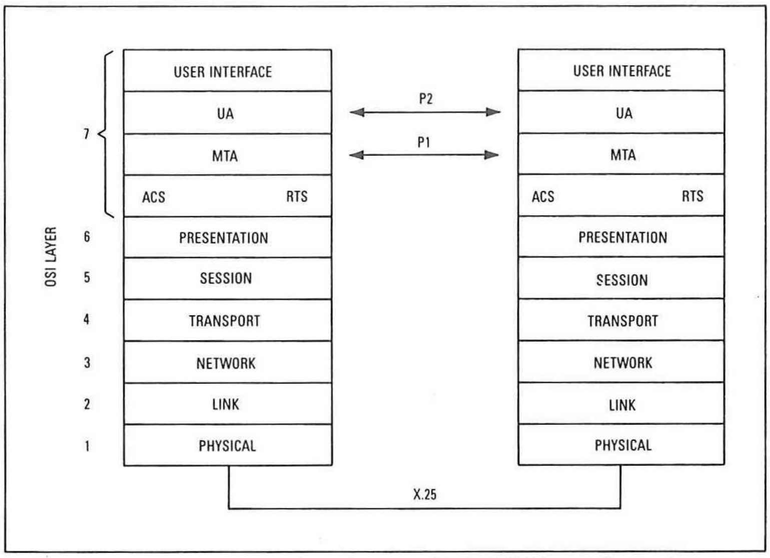
7. Application

The Application layer defines the actual user application running over the lower layers. X.400 electronic mail is a good example.

X.400 AS AN OSI LAYER 7 APPLICATION

Within a given profile, the lower layers are defined and, in all profiles to date, the bottom three layers are provided by the X.25 standard for packet switching as implemented by BT in PSS.

Two layer 7 protocols are defined by X.400. These are the P1 protocol, which describes the transmission between message transfer agents (MTAs), and the P2 protocol which describes the interaction between user agents (UAs) (Figure 4).



ACS: Association control service RTS: Reliable transfer service

Figure 4—X.400 protocols

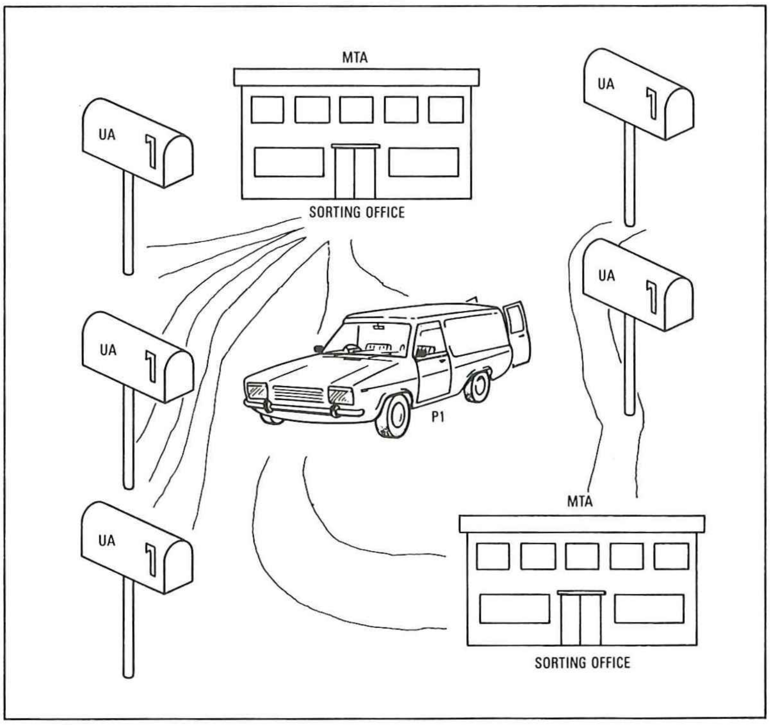


Figure 5—Postal analogy

STRUCTURE OF AN X.400 SYSTEM

An X.400 system consists of two principal components. The first of these is the message transfer agent (MTA) which can be likened to a postal sorting office where outgoing mail is either delivered to the recipient's mailbox if the recipient is local to the sorting office, or put on a lorry to a distant sorting office if the recipient is not local. In the case of X.400, the lorry is X.25 and the distant sorting office another remote MTA (Figure 5).

The second component is the user agent (UA), which acts as the user's mailbox, where, in the American tradition, incoming mail is placed until the user actually collects it, and in which outgoing mail can be placed for the mailman to collect and take to the sorting office.

Thus an X.400 mail user only ever sees his/her own UA and sees this through a user-friendly interface provided by the supplier of the X.400 software, as in this example from BT's TX400 product (Figure 6).

This structure is formalised in the X.400 message handling system (MHS) model (Figure 7). This shows the message handling environment containing the mail users. The MHS provides this mail service by means of UAs which communicate through a message transfer service (MTS). The MTS is provided by a network of MTAs as shown in Figure 7.

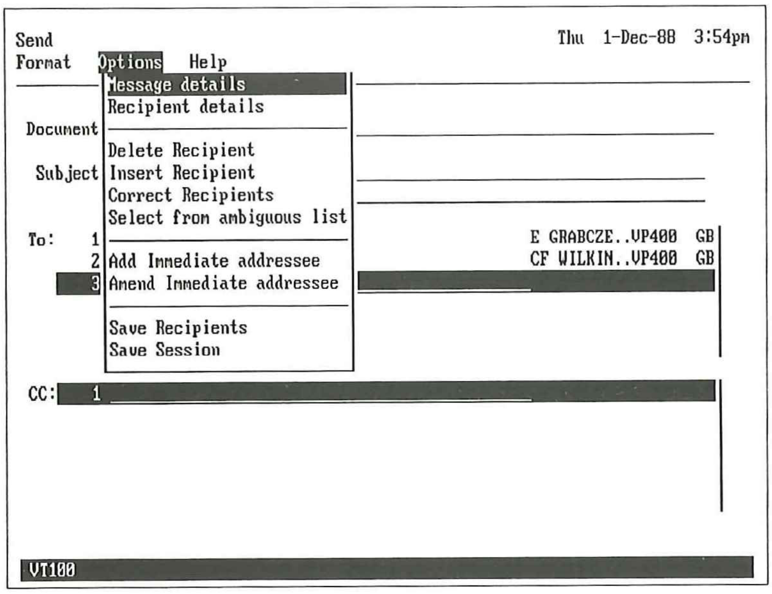
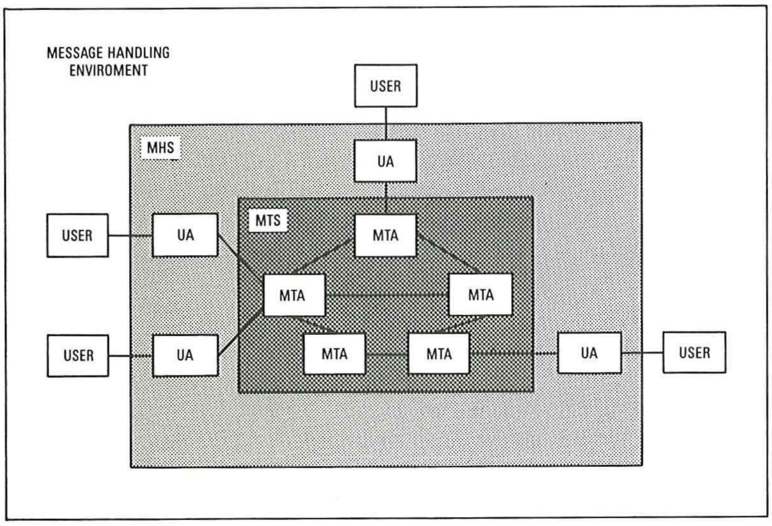
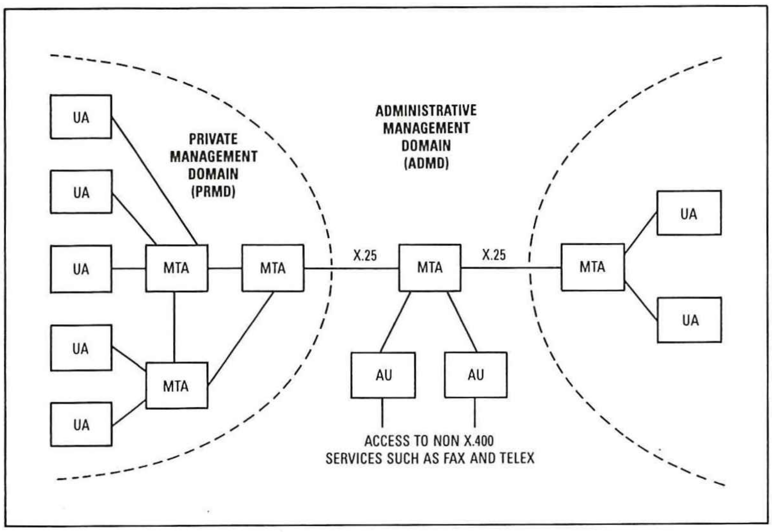


Figure 6—TX400 screen



MHS: Message handling system
MTS: Message transfer service
MTA: Message transfer agent
UA: User agent

Figure 7—X.400 MHS model



AU: Access unit

Figure 8—X.400 interconnection

NETWORK OF X.400 SYSTEMS

As has been suggested in the lorry analogy above, many mailboxes (UAs) are connected to a sorting office (MTA). A company may have several of these X.400 systems, just as they may have several PABXs, and, as with the PABXs, they may connect them together with a network. This forms what is known as a *private management domain* (PRMD). Note that a PRMD may consist of one or more MTAs, but, however many are involved, they must all belong to the same company. Note also that any one company can have as many PRMDs as it wishes.

There is also a public network of MTAs, known as the *administrative management domain* (ADMD). Messages passing from one PRMD to another may route direct over the PSS or may route via the ADMD (Figure 8).

Reasons for taking the latter choice are, for instance, that the routing to the distant PRMD is not known. The ADMD is able to ensure that the message is delivered.

FEATURES OF AN X.400 SYSTEM

Send Mail Preprepared files or memos typed on-line can be sent to one or more recipients (that is, a mailing list). Optionally one or more 'carbon copy' recipients or one or more 'blind copy' recipients may be included.

Receive Mail Mail can be received from any other X.400 user anywhere in the world.

Store and Forward X.400 is said to be a *store-and-forward* messaging system. This means that messages may be stored at various points in the system. For instance, if the line from the MTA is busy when a message is ready to be sent, the message is stored in a queue until its turn comes to be sent out. There are ways of ensuring that messages are delivered within a certain time and, generally, messages are delivered within minutes, but it is important to recognise that X.400 is a mail system and is not suitable for interactive 'conversations'. By the same token, Telex-style answer-back codes are not provided either, although other notifications listed below will confirm the recipient's identity.

Deferred Delivery A message can be put into the system with the specification that it should not be sent out before a certain date and/or time. Note that the time specified is not the time when delivery will take place, but the time when the message is sent from its home MTA.

Delivery Notification When mail is sent, the user can request notification of delivery. This is returned to the user when the message arrives at the destination MTA.

Non-delivery Notification If this is requested, a notification is returned to the user if the mail sent cannot be delivered. It is quite acceptable to specify both delivery notification and non-delivery notification on the same message.

Receipt Notification The user can request receipt notification and it is returned to the user when the recipient actually collects his/her mail from the mailbox.

Non-receipt Notification As with delivery and non-delivery notifications, the user can also specify non-receipt notification. This is returned to the user when, for instance, a message is autoforwarded to another recipient.

Autoforwarding When going away on holiday, the user can specify that all his/her mail should be autoforwarded to someone else. The user can tell the system the reason for autoforwarding, for example, 'On holiday until 10th March' and this message is returned to the sender with the non-receipt notification.

Alternative Recipient This caters for messages that arrive correctly addressed for a PRMD but bearing an unidentifiable recipient name. These are normally delivered to a 'post room' where someone has the responsibility of looking at the addressing information and trying to deduce the intended recipient. The sender has the option to allow or prevent this alternative recipient process to take place.

Reply Request The user can request a reply to a message. The request can specify the date and time by which the reply should be sent, and it can specify the list of recipients to whom the reply should be addressed.

Conversion Gateways to other networks, such as Fax and Telex, can be provided on X.400 systems. They are already provided on the BT ADMD, Gold 400. The nature of X.400 addressing is such that the sender may not be aware that the intended recipient has a Telex machine not an X.400 terminal. The message is, quite automatically, translated to Telex format. However, because the message may 'lose something in the translation', the sender has the option to specify that conversions should not take place. If a message with this option set arrives, say, at a Telex gateway, it goes no further, and a non-delivery report containing the reason is returned to the sender.

Other Message Attributes Other attributes that can be set by the sender are *sensitivity, expiry date, priority and importance.*

THE FUTURE

As already mentioned, the original 1984 standard has been enhanced to become the 1988 standard with several new features. It will be about the beginning of 1990 at the earliest before fully featured products to 1988 standards are available.

Fortunately, 84 standard products will interwork with the new standard and most suppliers will offer an upgrade path from 84 to 88.

NEW FEATURES OFFERED BY 1988 STANDARD

As far as the user is concerned, the main features of 88 are:

Better Security A whole range of perceived security threats are dealt with such as masquerade, message modification, replay, traffic analysis and repudiation.

Physical Delivery As well as addressing a mail item to other X.400 users, Telex users and fax users, as is possible with the 1984 standard, the 1988 standard provides physical delivery, which allows the inclusion of recipients who have no electronic mail facilities at all. Their mail will be printed off at some predetermined point and delivered by the normal postal service or by courier as appropriate.

Better Use of Mailing Lists The way mailing lists are handled is improved. This could, in some cases, reduce the cost to the user of sending mail to everyone on a mailing list.

Better Alternative Recipient Alternative recipient features are improved. The 1984 standard had one alternative recipient or post room for all the UAs attached to one MTA. The 1988 standard includes the ability for both the originator and the recipient to specify alternative recipients, and defines the order in which these alternative recipients are invoked.

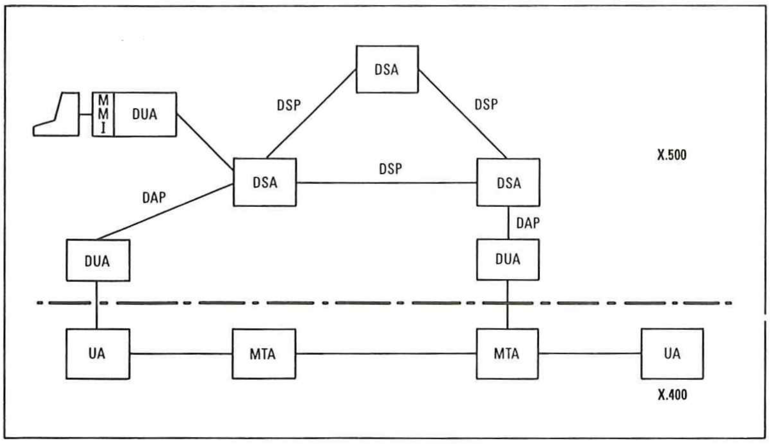
Use of the X.500 Directory The need to translate a common name, such as Joe Soap, into a name that is unique in the world was alluded to whilst describing the features of the basic (84) standard above. The 84 standard says little about how this should be achieved and, in all products produced to date, a simple local address book has been provided. This has to be kept up to date by the user or a specified administrator.

X.500 is an international standard, like X.400 agreed by both CCITT and ISO, for a global directory (see below).

X.400 as a Vehicle for Electronic Data Interchange This is not a part of the 1988 standard, but, currently, the area of a lot of standards formulation work is the exciting idea of using the concepts and the software developed for X.400 to transport electronic data interchange (EDI) messages. These EDI messages, which are, for instance, invoices or orders, are currently sent over specialised networks. Clearly, it is far better to set up one general purpose network with all its rich features for both mail and EDI, and, perhaps in future, other services, than to have a dedicated network for each service.

X.500 DIRECTORY

Anyone who has used an electronic mail system will know the frustration of not being able to send mail to another user of the system because this user's identity or name is not known. Anyone who has administered an electronic mail



DAP: Directory access protocol
DSP: Directory system protocol
DSA: Directory system agents
DUA: Directory user asgent

Figure 9
X.500 directory

system will know the problems associated with keeping even a small electronic directory up to date as people come and go and organisations change.

It is clear that, if X.400 is to achieve its objective of becoming a global mail system, the problems of implementing and maintaining a global directory must be solved. As mentioned above, this is the subject of the X.500 standard.

X.500 is another OSI Application layer. It defines a network of directory system agents (DSAs) and directory user agents (DUAs). The network of DSAs form a distributed database. The DSA network is accessed by the DUAs (Figure 9).

A DUA may coexist with an X.400 UA in a user workstation. In this case, it is likely to have a common user interface with the X.400 system. The user can 'look up' the intended recipient by specifying the full name (for example, J. Smith) or by some other attribute such as organisation code (for example, CSD/SD2.1). The DUA then passes the rather complex global name, in X.400 terminology, the *originator/recipient name* (O/R name), directly into the UA without user intervention.

A DUA may also coexist with an MTA, where it has no direct user interface but provides the MTA with the ability to resolve names, as specified by the user, into O/R names.

While this article primarily discusses X.500 as it is applied to X.400 systems, it should be noted that a DUA can also stand alone. For this purpose, it will be packaged with a man–machine interface (MMI), and will be used, for instance, by PABX operators.

DUAs access the DSAs by means of a communications protocol known as *directory access protocol* (DAP). DSAs access each other by means of the *directory system protocol* (DSP).

A DUA is normally connected to a specific DSA. A request for a directory lookup is made by the DUA to its DSA. The DSA first searches its own information base (database) for the entry. If it fails to find it, it routes the request to other DSAs according to a predetermined algorithm until either the entry is found or until all DSAs have been searched.

FACSIMILE

Fax is a simple widely used form of electronic mail. With the current Group 3 fax machines, it is also highly standardised. However, fax can only do one job—transmitting a scanned image of a document from one place to one other.

X.400 systems can carry facsimile documents within their envelopes, but they can do much more. As already described, they can transmit text messages to one or many recipients, error free, with a whole range of useful notifications and options.

The X.400 system is also capable of sending and receiving 'revisable documents', spreadsheets, computer program source and object files, and virtually any other computer file in the same simple and robust way. Revisable documents are documents produced by a word processor which contain formatting and layout information. The advantage of sending this type of document rather than one in plain text is that the recipient can feed it into a word processor and revise it or edit it without having to retype it all. It is always necessary to retype a faxed document if editing is required (see below).

Another problem becoming increasingly common in business today is that of secretaries spending hours trying to get through to a busy fax machine. This problem does not happen with X.400. Because X.400 is store and forward, the user can prepare and post a message when it suits, and the system transmits it as soon as it is able.

REVISABLE DOCUMENTS AND THE ODA STANDARD

The concept of revisable documents was raised above. It was suggested that a document produced by a word processor could be transmitted to a distant recipient who could re-input it to a word processor and re-edit it.

This is only true in practice if both the originator and the recipient have the same word processor because all the control information that a word processor builds into a document to indicate, for instance, bold text, underlined text or italics is peculiar to that word processor. In other words, WordStar® cannot edit files produced by WordPerfect or Microsoft® Word without a translation process to convert the formatting information.

Again, the standards bodies recognised the problem that, with n word processors in existence, n^2 translators would be required to convert from any to any. They were already working on a standard which provided a solution to this problem. This was a standard which defined a revisable document that, in essence, contained a superset of the facilities offered by all the word processors. This standard is known as the *CCITT T.400 series* and as *ISO 8613, Office Document Architecture and Interchange Format* (ODA).

Thus with this standard in place, an X.400 user who has, say, WordPerfect needs only two translators, namely WordPerfect to ODA and ODA to WordPerfect, to be able to send documents to, and receive them from, anyone else regardless of what word processor they are using. Transmission will always be of ODA documents (Figure 10).

By using this method, only $2n$ translators are required for n word processors. Once the standard becomes widespread, it is likely that word processor suppliers will provide a direct ODA output, thus avoiding the need for translation altogether.

The T.400 series of standards already goes well beyond simple revisable documents. It includes fax and vector graphics, but, as with X.400, work on further enhancement is underway to include such things as advanced graphics, colour, transmission of spreadsheets and many others.

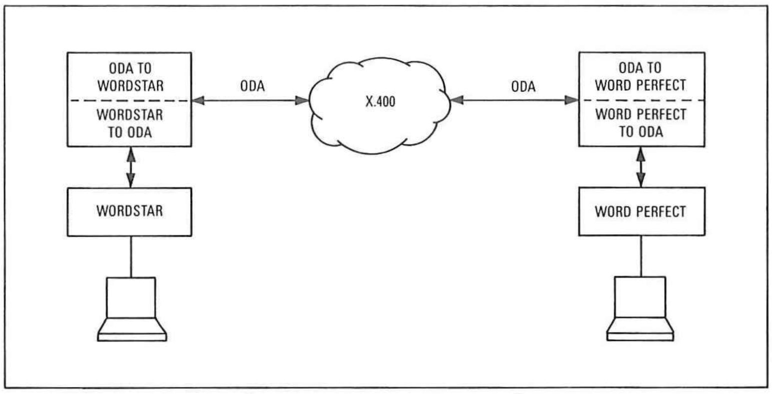


Figure 10—Example of ODA conversion

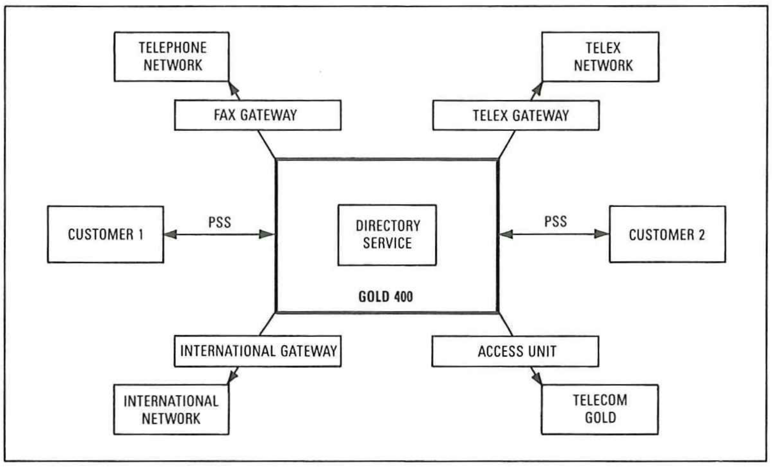


Figure 11—Gold 400

BT X.400 PRODUCT PORTFOLIO

BT currently has a number of products which implement the X.400 (84) standard. Work is in hand on X.500 and ODA products.

Gold 400

This is the ADMD product. It is currently the only ADMD in the UK.

Services provided are relaying (tandem switching), a gateway to Telecom Gold users, gateways to fax and Telex, an international gateway and a (non X.500) directory service (Figure 11).

It is expected that an X.500 directory will be used when a practical implementation becomes available.

PC/MTA

This product is not a stand-alone X.400 system. Rather, as its name suggests, it is an implementation of the MTA on a personal computer (PC). It consists of an X.25 interface card and associated X.25 software, a Transport layer interface, session and reliable transfer server from the BT generic software stack, the MTA itself and a Mailroom. The latter is responsible for acting as an intermediary between the MTA and the UAs. When a UA submits mail, the Mailroom passes it on to the MTA. When mail arrives for a UA, the Mailroom files it away. If the user is logged on, he/she receives a note to say that mail is waiting. If the user is not logged on, the mail remains in storage until the user does.

PC/MTA is provided as a systems component that can easily be engineered to attach to non-X.400 electronic mail systems to provide a quick and relatively inexpensive gateway to the X.400 network. Figure 12 shows the PC/MTA with three examples of possible connection methods to the host system.

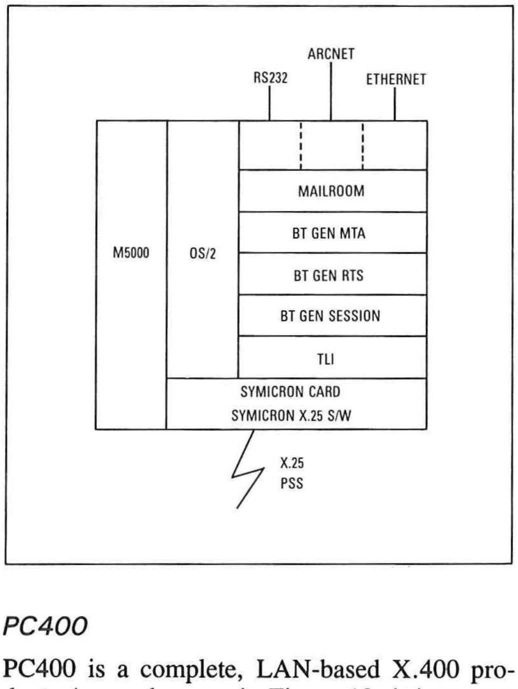
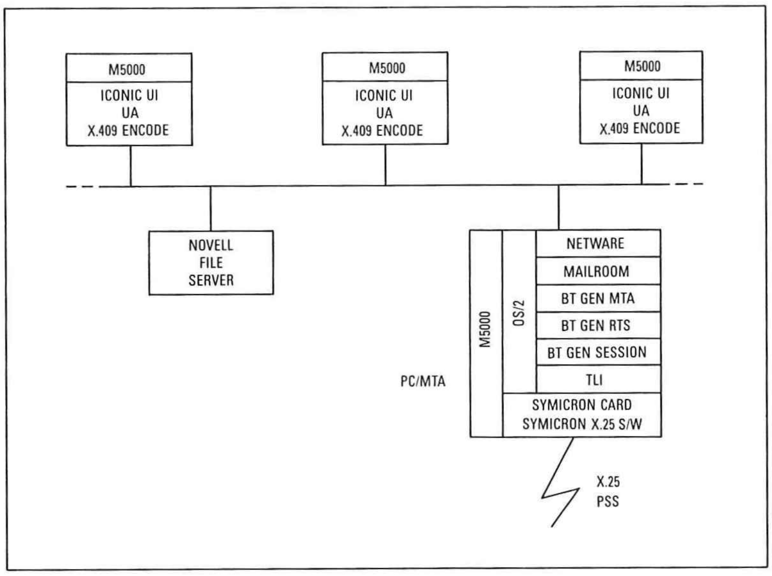


Figure 12 PC/MTA

PC400

PC400 is a complete, LAN-based X.400 product. As can be seen in Figure 13, it incorporates PC/MTA. The workstations have user agent software which has a simple-to-use iconic interface, shown in Figure 14.

PC400 runs on the BT T-NET series of LANs as well as many others.



TLI: Transport layer interface

Figure 13—PC400

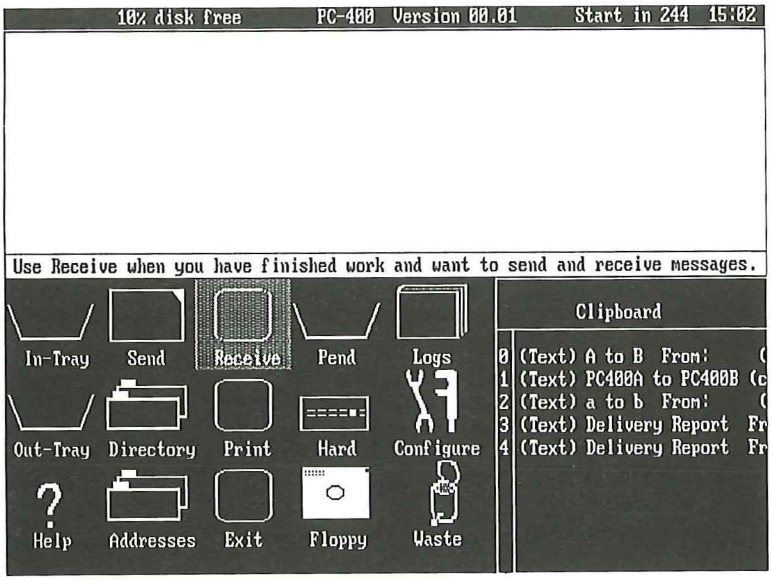


Figure 14—PC400 iconic interface

TX400

TX400 is the generic series of products currently implemented on the DEC VAX range of computers under the VMS operating system (TX400-VP) (Figure 15) and under the UNIX operating system specifically for the BT M6000 range of mini computers, but is readily portable to other UNIX machines (TX400-UP) (Figure 16).

TX400 is a fully ONA conformant X.400 system. The user interface (Figure 6) features pull-down menus and conforms to the ONA Style Guide character based interface (CBI).

CONCLUSION

An international standard for electronic mail has been agreed by both the CCITT and ISO. With the addition of the X.500 directory and the ODA to enhance the practicality of using the system, the X.400 implementations which are now starting to appear will soon become established products. For the first time, the prospect of global electronic mail will become a reality.

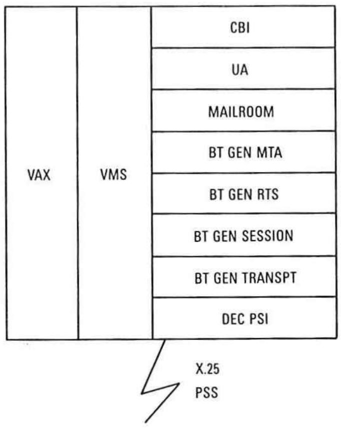


Figure 15—TX400-VP

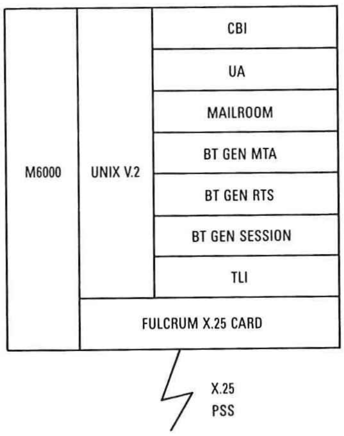


Figure 16—TX400-UP

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Biography

Chris Wilkinson joined the GPO in Tunbridge Wells Telephone Area and, after his apprenticeship, worked as a technician on repeater station equipment. He moved to Headquarters following his success in a Limited Competition. He has spent most of the last 23 years working on various computer projects and providing support services for other BT computer users. He is currently working in the area of Communications Systems Division responsible for the development of X.400 systems. He has an M.Sc. in Electronics, is a Member of the British Computer Society and is an Associate Member of the IEE.

Commercial Opportunities in Serving Major Customers

K. MORGAN†

This article is the paper presented by the author at the 28th European Telecommunications Congress held in Lisbon, Portugal, from 3–9 September this year. The author surveys the communications opportunities which 1992 will present. Using British Telecom's experience in the competitive environment, he expresses his ideas for the future of the European PTTs.

INTRODUCTION

At conferences of this kind, one wants to focus very positively on the opportunities presented by the formation of a common telecommunications market in the European Community by the end of 1992. In analysing the possibilities, there is a risk that the debate may sound like one of mutual reassurance between the players. The ideas can sound so enterprising and logical that one may feel that they are already *faits accomplis*. However, I would like to suggest that the process will encompass much sweat and pain before we arrive at a point where we regard the situation as satisfactory.

The vision is a complex one, and in this paper I can only give my personal view on a few of the issues which will need to be considered in this radically changing scene. I certainly do not have any model within which I can point to precise parameters which will define the course of European communications. But I hope I can convince you of the excitement and determination with which many of us in British Telecom view the opportunities of 1992 and beyond.

TECHNICAL STANDARDS

During my presentation, I will deal predominantly with the commercial and regulatory aspects of 1992, but let us spend a few moments considering the engineering side.

The technical problems which face us in trying to expand and integrate communications on a large scale are enormous, and one should not underestimate the work which will be required to achieve consistency across Europe. A key factor is the writing and full mutual recognition of standards, and a great deal of work is being carried out in order to define the standards which are crucial to maximise interworking and ensure fair conditions of competition. The progress of formulating NETs (*Normes Européènes des Télécommunications*) has been assisted by the establishment of a specialised institute at Nice, known as the *European Telecommunications Standards Institute* (ETSI). A NET is a common conformity test specification which will be applied to apparatus which is to be attached to the public network. NETs will be used for type approval of terminal equipment and the results will be recognised by the PTTs in respect of connectivity to their own national networks.

Our Deputy Chairman recently expressed some concern at the apparent lack of customer involvement in Community planning and observed a tendency to regard the customers as more or less grateful and passive recipients of Euro-products, Euro-services, and Euro-network offerings. He appealed for a greater dialogue with our customers so that we focus more on core customer issues such as quality, flexibility and choice. I will have more to say on this subject in due course.

1992

What differences will we notice as we cross the threshold of 1992?

For most PTTs, 1992 represents the transition between two very different types of culture. Most will progressively be leaving a position of protected monopolies, and entering the world of competition; leaving the position of PTT pronouncement on what is best, and entering the world of customer demand; leaving the position of trying to do only what is reasonable, and entering the world where the more acid test is 'Is this possible?' As engineers we have to leave behind our Civil Service ideals of perfection at any price, and rise to the commercial challenge of customer satisfaction at a competitive price.

The Single European Act is of itself only enabling legislation to prevent artificial barriers from being introduced or retained. It sets the climate for healthy competition. But the concept will succeed only through the determination and perseverance of those concerned. As we look around, it is quite clear that there are a number of commercial enterprises already alert to the opportunities of 1992. Many have been competing for some time in those areas already liberalised. Others are poised to take advantage of new opportunities. At present most PTTs are

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protected by regulatory barriers which make competitive entry into certain domains illegal or commercially unattractive. We must not, as PTTs, rest on our laurels, basking in the comfort of such protection. As digital technologies converge, the distinction between basic and value-added services will hold progressively less meaning. The spirit of 1992 will be infectious, and customers and suppliers alike will push for further deregulation, both nationally and across European boundaries.

What the customer wants and technology can provide, the regulator will sooner or later allow.

THE SINGLE EUROPEAN ACT

As it is central to the theme, let us take a brief overview of the Single European Act. The Act came into force on 1 July 1987. The aim of the Act is to 'promote a harmonious development of economic activities and a competitive market throughout the community'. For some years prior to this time, the member nations had signified a number of 'good intentions', but it became evident that progress would only be made if definitive action was taken. The Single European Act puts in place a specific framework which is to take effect from 31 December 1992.

The Act incorporates the following measures to be taken within the Community:

- No country should be able to refuse to buy goods or services from another country on the grounds that they do not meet their national standards.
- No country should restrict the extent or nature of the incoming or outgoing capital flows.
- Goods should be able to move freely throughout the community.
- Governments should open their public purchasing and consider and award tenders from all countries judging on independent merit and price.
- Financial and professional services should be provided on a Europe-wide basis.

The Green Paper which was published in 1987 outlines the Commission's view of the development of communications towards 1992. Some of the major points are:

- Progressive introduction of regulatory changes leading up to 1992.
- Account to be taken of all interested parties: users, administrations, work-forces, manufacturers.
- Competition in services and terminal equipment to be expanded.
- Safeguarding of PTT infrastructures to permit service obligations for a restricted band of 'reserved' services.
- Review of artificial boundaries between 'reserved' and 'competitive' services as technology develops.
- Faster establishment and application of standards.
- Separation of regulation from operation.
- Harmonisation of network facilities (technical regulations, termination points, usage conditions, tariff principles).
- Competition in satellite links subject to appropriate regulation.

OPPORTUNITIES AND THREATS

The aim of the Single European Act is to enable customers at last to have the exciting prospect of being able to choose to have the same products and services throughout the community, without national distortions. Communications will play a vital role in enabling companies to offer their products and services Europe-wide. And the same opportunity applies to communications products and services themselves; the ideal is that they should be universal, subject, of course, to technical compatibility with existing national infrastructures.

But how are European telecommunication networks to be developed when they do not exist for the most part? It is true that some multinationals have European networks which have been put together over the years after much pain and skirmishing with the PTTs. Some sectors, like banking and finance, have shown the way, adding a European dimension to their communications as an integral part of their developing markets.

But for the most part, our customers' European communications are unstructured and superficial, if they exist at all. It is our challenge to awaken them to the new horizons which 1992 and communications can open up for them. For many types of business, communications is the essential ingredient which enables the efficient control of a geographically diverse operation. Because of the scale of such ventures and their dependence upon communications networks, there will be opportunities for ongoing profitable business for telecommunications providers. Our success in winning this business will depend on our ability to respond flexibly and positively across boundaries (some real and some artificial) which were hitherto regarded as impermeable. Many such responses will require imaginative solutions to customers' problems which add value to basic services, or which combine basic services in new ways. As regulatory impediments disappear, the remaining limitations will revolve around our ability to conceive designs and gain product support for new ventures. We need to understand our customers' business, understand what is important to them, and ensure that we know more about the cost-effective solutions to their communications problems than they do.

As I have already suggested, we must not assume that even the basic voice network will be ours for the taking. Many of our major customers already have large national private networks. At this moment, it would only take the stroke of the regulator's pen to open the way for further resale with the consequential effects on our vital revenue streams. As voice becomes just another

bit-stream, it will become increasingly difficult to detect abuses of regulations and prevent them from occurring. We have to offer a sufficiently attractive service that our customers want to stay with us. It would be advantageous if the PTTs could enhance the co-operation and interconnectivity between themselves, so that our customers find it a rewarding experience to deal with us in setting up their European voice networks. There are many horror stories which point to this not being the case at present. We ignore such cases at our peril. As one wise man has said, 'You do not have to do any of this; survival is not compulsory!'

BRITISH TELECOM EXPERIENCE IN THE COMPETITIVE ENVIRONMENT

As you know, British Telecom's environment is very different in 1989 from the way it was at the beginning of the decade, and very different from the environment in which many of you work. Changes include the liberalisation of the apparatus market (during which we lost the monopoly in some areas and gained entry to others), privatisation of the company (whereby we now have a large number of public shareholders), and the duopoly with Mercury for network services. My observations come from the totality of this background.

Firstly, the business is increasingly customer-led, although some parts have been lamentably slow in achieving this culture change. When customers have a choice of suppliers, they can weigh up what they get for what they pay. It is doubtful whether the PTTs will ever be (or wish to be?) low price providers, and therefore we must be perceived as very professional and responsive providers of quality solutions. We have major advantages in the universality of our coverage and the extent of our portfolio; we can offer 'one stop shopping', although in Britain, we have to ensure that any 'packaging' does not contravene the rules of fair market competition with our competitors. But how much effort is involved in co-ordinating multifaceted projects to achieve an integrated solution? From my experience, national projects are an order of magnitude more difficult than local ones, and international projects represent a further order of magnitude. There is no inherent reason in terms of engineering complexity why this has to be so; the vast majority of problems are bureaucratic and logistic and we have been working hard in British Telecom to improve this situation. We still have a long way to go, but we have made significant progress.

The battle for customer satisfaction is a continuous and frustrating one. At the same time as we have been improving our performance, customer expectation has been rising rapidly—sometimes due to external forces, and sometimes self-inflicted. And this brings me to my next point: once the spotlight turns on the customer, the quest to satisfy his expectation profitably never stops; it becomes part of our daily business. Given a large enough resource and plenty of time, there is no problem. The challenge is to achieve customer satisfaction profitably and in his timescale.

British Telecom has been introducing Total Quality Management (TQM) throughout the company in order to assist us with the above task. Quite simply, we aim to get it right first time every time. TQM is a practical method of progressively tackling each of the many things which go wrong every day, and finding a better way. Many parts of the business are using TQM in conjunction with ISO 9000, the European standard for quality systems. ISO 9000 demands that our systems be documented, understood, and implemented by all members of our teams. In brief, the motto is 'Say what you do, then do what you say'. The standard also requires a method for corrective action to be instituted so that failures are put right. ISO 9000 plus TQM are valuable tools for achieving consistent results for our customers.

Over the last few years, British Telecom culture has been changing significantly due to the customer emphases I have mentioned, and the requirement to satisfy our shareholders. We have, therefore, faced the double demands of dramatically improved quality and significant cuts in operating costs. In a number of areas, we are now able to give a level of service which we would have declared to be unreasonable and impossible a couple of years ago. This has been, and will continue to be, a painful process, but very few of us would wish to return to the old way of life.

To complete the picture, I would like to include a few words on Mercury and OFTEL. OFTEL (the independent Office of Telecommunications) has the regulatory role in Britain. It takes account of the interests of customers, manufacturers and operators, and has a duty to ensure 'fair play' and encourage competition. As you will know, British Telecom's main competitor is Mercury. Over the last few years, the relationship between British Telecom and Mercury has started to mature. Certainly we are in direct competition, but we understand better that we have to work together in many environments in an aggressive but business-like fashion, with OFTEL in the wings as the referee in the exceptional circumstance that our customers feel they are dissatisfied with the service they get.

I mention this situation because I believe the European scene could go through a similar period of adolescence before we emerge as mature adults. With the liberalisation of service in Europe, relationships between the PTTs will change. After 1992, the PTTs will sometimes be working in co-operation and sometimes we will find ourselves in competition; my hope is that we will achieve business-like interworking relationships in the shortest possible time.

THE WAY AHEAD

So what then is the European scene beyond 1992? Many experts believe we will see an initial upsurge in the number of firms who are competing for business, as we have seen during the liberalisation of the 1980s. However, during the 1990s. the favoured scenario is that rationalisation will take place so that there remains only a smaller number of major players in Europe, and, indeed, in the world.

Where will we be in this scenario? I suggest we will be where we corporately strive to be. If we sit back and do nothing, we will retain the protected business for as long as such protection is meaningful, and we will retain the less interesting or less profitable business which commercial enterprises do not want. But if we want to be players in the exciting and rapidly expanding new areas of communications on the pan-European scene we must quickly ensure that our company cultures are in line with competitive requirements.

As engineers we have to face the required culture changes philosophically and positively. We must ensure that we realign our activities and efforts to support directly the commercial and customer-related interests of our companies whilst upholding the essential standards of our profession. Those of us in customer-facing jobs may have to drag our more sheltered colleagues with us screaming. I do not believe this is a betrayal of engineering; on the contrary, the pragmatic and cost-effective application of technology is an integral part of the engineering function.

As I have said, I do not think there is any one universal formula, which defines the way ahead. However, I will summarise the areas to which I believe we need to give heed:

- *Firstly* Listen to our customers. The majority of our new work will spring from our own national customer bases. More than ever we have to retain our customers' trust and be proactive in working integrally towards their European opportunities. I suggest you might form an opinion at this Conference as to how far down the 1992 track each administration has come by observing how often they mention the word 'customer'.
- *Secondly* Do our basic work right first time every time so that we retain the confidence and loyalty of the customer. And bear in mind that monopoly services will not always be so, and we should therefore be as vigilant in these as in the competitive areas.
- *Thirdly* Develop new solutions, either by imaginative combinations of existing services, or by value-added services tailored to the customers' needs.
- *Fourthly* Quickly aim for a maturity of relationship between ourselves whether in the protected or competitive areas, so that we do not give outside interests the opportunity to sneak in whilst we are involved in inter-PTT squabbling.

I, and many others in British Telecom, are looking forward to the challenge of 1992. I encourage you to join us in this, and to ensure that we do not seek to defend old ways of thinking which would inhibit the achievement of the European vision.

Biography

Keith Morgan has a degree in Physics and Electronic Engineering at Manchester University. He has also completed postgraduate studies in Communications and Management at Sydney University (Australia). He is currently Head of Engineering in National Account Management (NAM). NAM is responsible for ensuring that British Telecom continues to have a healthy and profitable relationship with its major customers. Previously, he was Head of Major Projects Division in West End District, and worked with Telecom Australia prior to joining BT.

Rising Groundwater in Urban Areas—Implications for British Telecom

D. G. CLOW†

This article describes the results of a study into the effects of the reduction of abstraction of water from beneath London which is causing groundwater levels to rise rapidly towards the natural level. This rise could have undesirable consequences on buildings, tunnels and underground ducts and jointing chambers. The reasons for the changes in groundwater level are outlined and a preliminary assessment of the effect on structures is made.

INTRODUCTION

The behaviour of the soil in terms of changes in strength and volume is dependent on its water content. It follows that changes in the water content of the ground are likely to influence man-made structures which rely on the soil for support. In the case of British Telecom, structures liable to be affected include foundations and therefore the buildings they support, building basements, the cable duct and jointing chamber network, and deep-level cable tunnels.

In several conurbations in the UK, BT buildings and underground plant were constructed in a period when the abstraction of water from the ground had already caused the groundwater to fall well below its natural level. In recent years, however, the reduction in abstraction has caused the groundwater levels to begin to recover, the ultimate limit being a return to the original water table. The result will be that many foundations and much buried plant will begin to experience for the first time a wet or a wetter ground environment. Certainly no UK urban area will experience extreme effects like those cited in the box on this page, yet potential ground movements cannot be ignored, as the serviceability or stability of structures could be at risk. This article describes a major study which has been undertaken to assess the possible engineering consequences of rising groundwater in the deep aquifer beneath Central London. Further work in London is being undertaken, and an examination of the situation in other cities is likely.

PROJECT BACKGROUND

In a number of cities in the UK and elsewhere, structural problems and increases in ingress of water have been identified as being the result of a rise in groundwater level. Outside London, some structural damage has already occurred to one BT cable tunnel, and flooding of a telephone exchange basement has been reported. As a result of the concern of civil engineers, the Construction Industry Research and Information Association (CIRIA), of which BT is a member, proposed an investigation into the situation in central London as the water level in the deep aquifer of the London Basin was known to be rising rapidly. BT agreed to contribute to the research and then participated in the research steering group, initially because the important deep-level cable tunnel network would be among the first man-made structures to experience the rising water. As the project progressed, it became apparent that the duct network and operational buildings could also be affected.

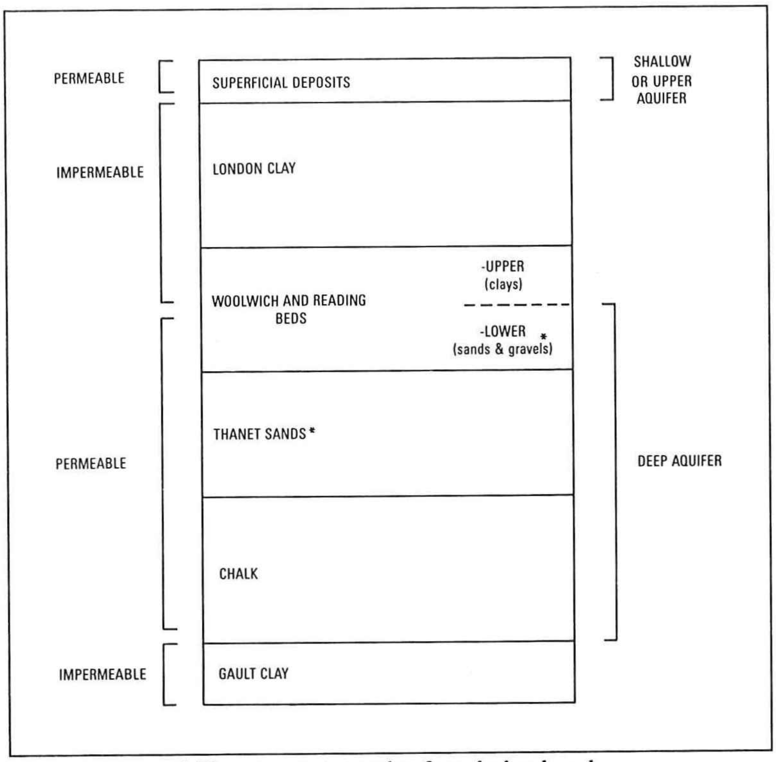
CIRIA is an independent non-profit-distributing organisation for carrying out research and providing information for the construction industry. It has about 600 member organisations and companies. CIRIA does not undertake research itself, but places contracts for research with appropriate bodies, manages projects and publishes results. Previously BT has taken part in several other CIRIA projects, including re-

THE RESULTS OF GROUNDWATER EXTRACTION

A dramatic example of the effects of man's use of groundwater is given by the Palace of Fine Arts in Mexico City. When built in 1903, entry was gained by going up a flight of steps to the first floor level. Now entry is gained by going down steps to get to the first floor level! As a result of the abstraction of groundwater, the building has settled 3·6 m. It has not only settled bodily but severe distortions have taken place from uneven settlement. In addition to such a building settling, the general ground level in the city has subsided significantly. Strict controls on water abstraction have now had to be imposed, and new buildings are designed to cope with any future movements.

In England, in 1851 at Holme Fen, south of Peterborough, a cast iron pillar was founded in clay, its top being level with the peat surface. As a result of continuing land drainage, the peat has shrunk and the top of the pillar now stands about 4 m above the surface.

† Network Systems Engineering and Technology, British Telecom UK



* These two strata together form the basal sands

**Figure 1
London strata (generalised)**

search into the effects of wind loading on tall towers, the examination of the dynamic behaviour of guyed masts, and various projects related to tunnelling and underground construction.

Active participation in such projects enables BT to influence the direction of research, gain access to more detailed information than otherwise would be the case, and take part in projects which require a multi-disciplinary approach. The latter aspect has been especially important in the case of the groundwater study described here, for major inputs were required from the disciplines of geology, hydrology, geotechnology, civil and structural engineering. The interests of the owners of structures also needed to be represented.

HYDROGEOLOGY OF THE LONDON BASIN

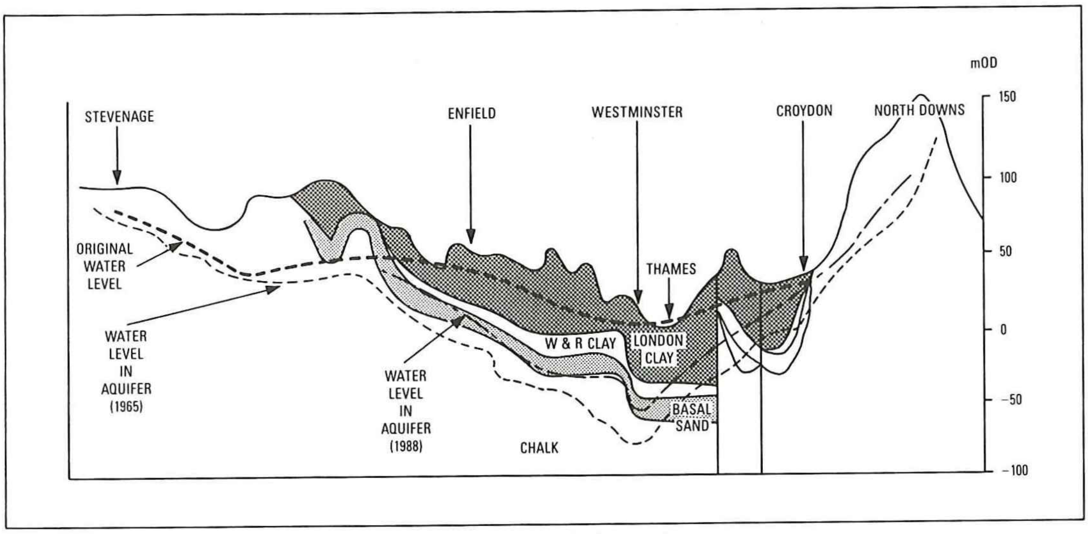
To understand what has been happening in London it is first necessary to examine its geology. The generalised sequence of strata is shown in Figure 1.

The important feature of this stratigraphical sequence is the alternation of permeable and impermeable strata. A soil is said to be *permeable* not only if it can hold a liquid within its fabric, but also if the liquid can pass more or less freely through it. Beneath London, the sands and gravels are both permeable. Solid chalk is porous but not permeable, but beneath London the chalk is heavily fissured and water is both stored by and transported through these fissures. Clay, although porous, is essentially impermeable and acts as a water barrier which hydraulically separates water in the permeable deposits below and above it. Water movement through clay is very slow indeed, although fissuring and lenses of sand and silt in the clays have a significant effect on the permeability of the clay strata.

Figure 1 shows two *aquifers*, or permeable water-bearing strata, from which it is possible to pump water. Currently, some 70% of London's water supply comes from the River Thames, but the deep aquifer consisting of the Chalk and Basal Sands is also used with wells in the Lee Valley and on the Kent side of the Thames. The shallow or upper aquifer overlies the London Clay and is at a high level in the Thames gravels, but is little used as a source of water.

Figure 2 is a typical cross-section of the London Basin which shows that the idealised sequence of Figure 1 is not universal under London. The Basin is a shallow *syncline* or sagging fold in the chalk and overlying deposits. Within this syncline there are many local variations of strata, perhaps most notably the geological fault south of the Thames shown on the cross-section.

**Figure 2
Cross-section of London Basin showing water level changes in the deep aquifer**



mOD: Metres above Ordnance datum

The study reported here dealt with the situation in the deep aquifer where an effective hydraulic seal exists provided by the London Clay between the deep and upper aquifers. There are two important situations in the upper aquifer which are the subject of further studies now being undertaken. One case is where no clay seal exists between two aquifers and so the two are in hydraulic connection. The other case will consider what is happening in the upper aquifer where it is isolated by the clays from the deep aquifer.

There is complication in that there are an unknown number of *scour holes* in the London Clay. These are of glacial origin and consist of local hollows penetrating down into the clay. Their size varies from tens of metres to a few hundreds of metres. It is known that some of these scour holes cut deeply enough through the clay to provide a hydraulic connection between the two aquifers. Scour holes are typically filled with alluvium and unconsolidated materials, and are important in civil engineering work as they give rise to rapid changes in ground conditions.

Figure 2 also shows the groundwater level at various times. The *groundwater level* is defined as that level at which water in a deep well will stand. The more familiar term of the *water table* is the plane forming the upper surface of ground fully saturated by groundwater. The level depends on the balance between water input and loss and, unlike surface water levels, changes in level take place slowly. The input to the deep aquifer is primarily rainfall on the hills surrounding the Basin; namely, Chilterns, North Downs, and Berkshire Downs. The output is provided by springs, flow out into watercourses, and abstraction by wells and pumping.

CHANGES IN WATER LEVELS

Prior to about 1800, London obtained its water requirements from three sources: wells in the upper aquifer, the River Thames and the New River constructed in 1613 to bring water from springs in east Hertfordshire. The first two of these sources became increasingly polluted by sewage. The level in the deep aquifer remained at the natural level until the late eighteenth century, when deep wells were sunk and the aquifer began to be exploited for water supply, ultimately supplying about 10% of the city's needs. Abstraction was made not only for public supplies, but also for private users who often found it cheaper to have their own wells rather than buy from the water companies. As a result of abstraction, water levels had fallen by tens of metres by the 1960s. In Trafalgar Square, for example, the level fell to 95 m below its natural level.

As a result of this abstraction of water, since 1865 the central area has subsided generally by some 200–250 mm. A major contributor to this subsidence was the shrinking of the underlying clay as it slowly lost its water content.

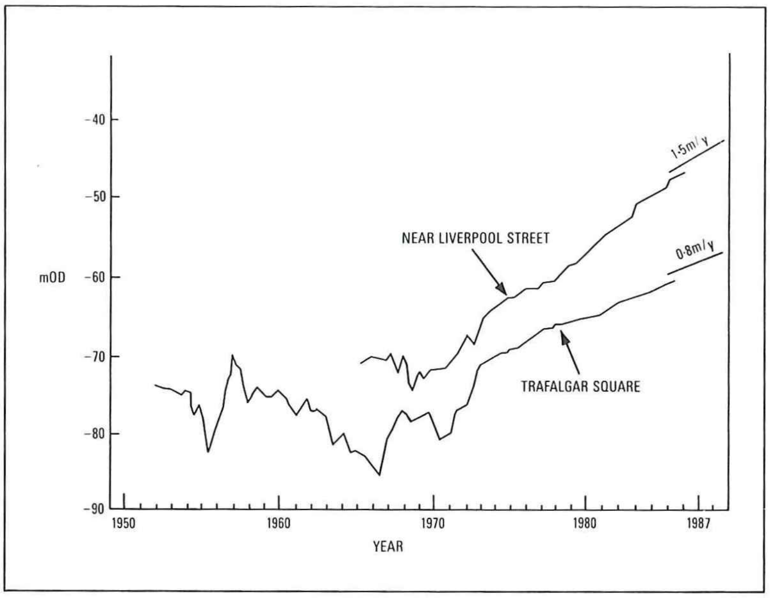


Figure 3
Rise in aquifer water level at two places in Central London

Since the mid-1960s, groundwater levels have been rising, typically by about 1 m/y in Central London, but as much as 1·5m/y at Liverpool Street. Figure 3 shows the trends for the last four decades from two borehole records. There are various reasons for the rise:

- There has been a reduction in abstraction as a result of licensing controls.
- Industrial decline has occurred in the central area leading to the loss of large users such as breweries.
- The costs of pumping have led to greater use of public supplies in preference to maintaining private wells (this means in effect that water is being imported into Central London rather than pumped from below it).

The total groundwater abstraction from the aquifer throughout the whole Basin is shown in Figure 4. It can be seen that the total abstraction has now levelled off at its highest ever level. Although the total has stabilised, there has been an increase in abstraction near the margins of the Basin which has balanced the reduction in the central zone.

The Thames Water Authority has been artificially recharging the aquifer in the Lee Valley to act as storage for use in time of drought, a technique which is to be extended to the Enfield/Harringay area. This recharging forms a water 'mound' in the aquifer, but little of this water will 'leak' into Central London and so will not affect the rate of rise of groundwater.

As the water level rises it is likely that about half the subsidence of the central area which resulted from abstraction will recover.

PREDICTION OF WATER LEVEL CHANGES

As the input to the aquifer in the central area now exceeds the losses, it follows that, unless some action is taken, the water will tend to return to its original natural level at some time

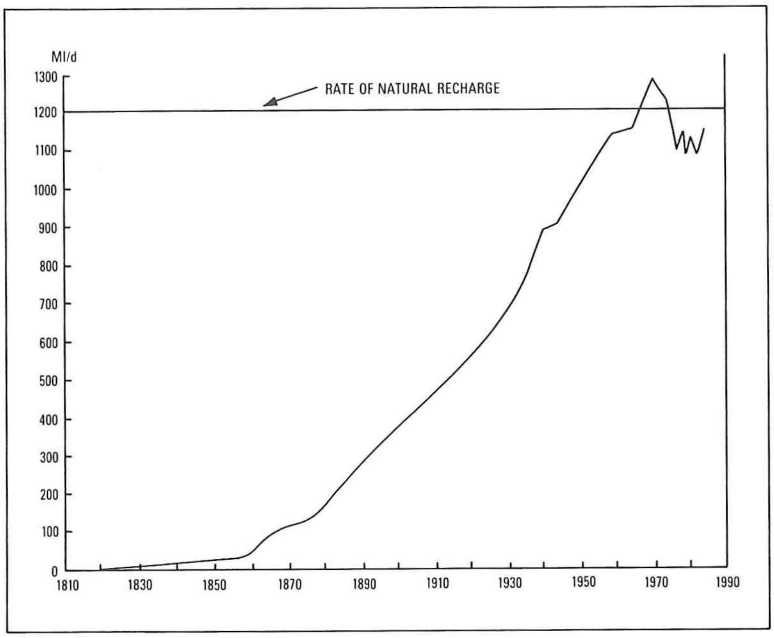


Figure 4
Total groundwater abstraction from the deep aquifer in the London Basin

in the future. When this might happen is of considerable importance to structure owners but prediction of the rate of rise is complex. In 1985, the Water Research Centre developed for Thames Water a numerical model to support the recharge scheme studies. The CIRIA study was able to make use of this model to examine a variety of scenarios. The results utilised for subsequent work assumed that public abstractions remained at the 1985 level and non-public abstractions reduced to zero by the year 2000. Figure 5 shows for one location the rise of water level predicted by the model. If the assumptions made in the modelling are realised, then the rate of rise would be such that water could return to its natural level under the City of London in about 20 years time. Outside the central zone the rate is likely to be slower. When evaluating the effects on a structure at a specific location both the rate of rise and the ultimate level are important factors.

EFFECTS OF WATER ON SOIL BEHAVIOUR

The potential problems of rising groundwater fall into four categories:

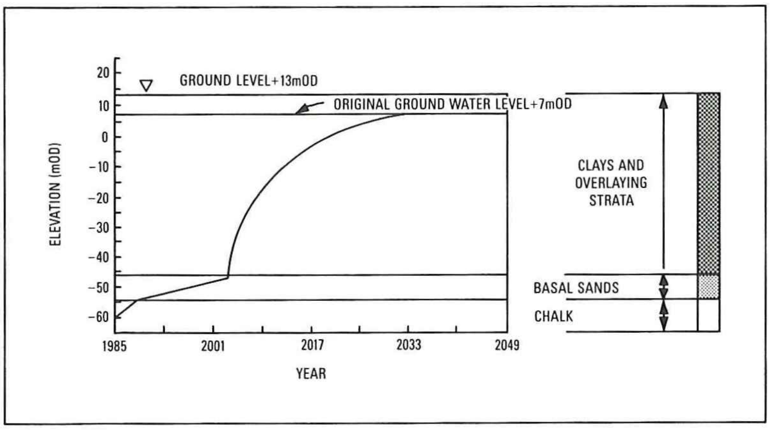


Figure 5
Predicted hydrograph for Trafalgar Square

(*a*) Saturation will lead to loss of soil strength and stiffness, and therefore its ability to support loads. The effects in soils found in the London Basin will probably be small and not likely to lead to problems except in a small minority of cases.

(*b*) Volumetric changes will occur as the soil becomes saturated. Clay shrinks as it dries out and recovers in part when re-saturated. Loosely-compacted granular soils such as sands and gravels will compact when saturated. Both swelling and shrinkage can have important influences on structural behaviour. Both types of soil occur in London, so the estimation of effects on a structure must take into account any variation in soil in both the horizontal and vertical planes at its site. Any volumetric change in the soil will lead to movements being imparted to a structure in or on it, and this is especially important where different parts of a structure move at different rates.

(*c*) Increased hydrostatic pressures will bear upon tunnel linings, basements and retaining walls.

(*d*) Chemical attack and hazards from naturally-occurring chemicals and from pollutants at former industrial sites may be activated by the rising water.

POSSIBLE EFFECTS ON STRUCTURES

Structure types owned by BT likely to be affected fall into three broad categories:

Deep-Level Cable Tunnels

The cable tunnel network will be the first to be subjected to the rising water. Most of these tunnels were constructed using cast iron segments, but a few more recent tunnels used concrete segments. Any problems encountered are not expected to be serious, although some increase in water ingress may occur. Considerable care has traditionally been taken to exclude water from cable tunnels by caulking with lead or cement between the segments in order to give acceptable working conditions, and this past care should minimise future difficulties. The increased water pressures could lead to some minor damage to concrete segments where these have been used. Of the total length of tunnels, only about a quarter is in strata where any change in environment could be significant.

Duct/Jointing Chamber Network

The underground cable duct network has not been designed for hydraulic tightness, but as most of it is at a shallow depth, any increase in pumping which might be required is likely to be confined to a few localities. Most of the water which enters this network is surface run-off, except where the groundwater level in the upper aquifer is near to the surface. Localised pollution problems could also occur from chemicals leaching out of the soil in specific localities as

the rising groundwater activates, what are at present, immobile pollutants. Examples of locations where problem could arise would be in the vicinity of sites of abandoned or war-damaged gas works, creosote-loaded ground at old timber yards, and waste tips. Methane from lenses of peat or from waste tips could also be forced upwards. The strict practice of BT in gas testing prior to working in underground structures means that the presence of methane should not pose any additional hazard.

Buildings

The assessment of possible effects on buildings is much more complex to evaluate because of the wide variety of designs of foundation and superstructure. Some general comments however can be made at this stage.

(*a*) *Water Ingress* As the water level rises, structures which had previously been in the dry or else subjected to a lower head of water may experience a new or increasing problem from the ingress of water into basements.

(*b*) *Water Pressure* Increased pressures on basement walls and floors and on retaining walls could give rise to structural damage in the form of distortion and cracking.

(*c*) *Structural Movement* Ground movements resulting from swelling clays or compacting gravels leading to differential movements in the structure can occur in a variety of circumstances. There could be a change of strata across the area occupied by the structure; for example, where a building is sited over a scour hole or geological fault. More commonly encountered will be situations where a building has different types of foundation for different elements of the complex. There are a number of configurations which could give rise to difficulty. Figures 6 and 7 illustrate a common situation where a tower block has a piled foundation but the connecting low structure only needs shallow foundations. Figure 6 illustrates a case where clays predominate. There is negligible movement at the base of end-bearing piles supporting the tower, but the swelling of the clay causes a large movement at the level of the footings for the adjoining low structure which then tends to move upwards relative to the main building. Figure 7 is the same type of building. Again the main piled structure hardly moves, but the gravels beneath the footings of the low building compact as a result of saturation by the rising water. In this case, the low building moves downwards relative to the tower. In both instances there is danger of rupture in the connection between the tall and low buildings. A situation similar to Figure 6 was examined for a building in the City of London and a possible relative movement of 50 mm was calculated. Such a movement would cause serious damage to finishes and services to such a building.

Other potential problems from differential movements could occur with a piled raft, the combination of piles with a ground-bearing slab, or with a deep basements together with retaining walls or piles.

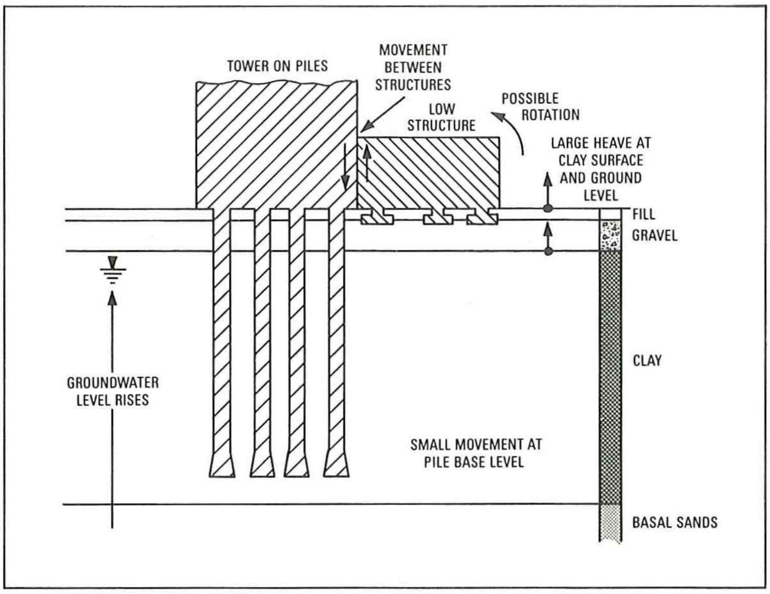


Figure 6—Differential heave in clays

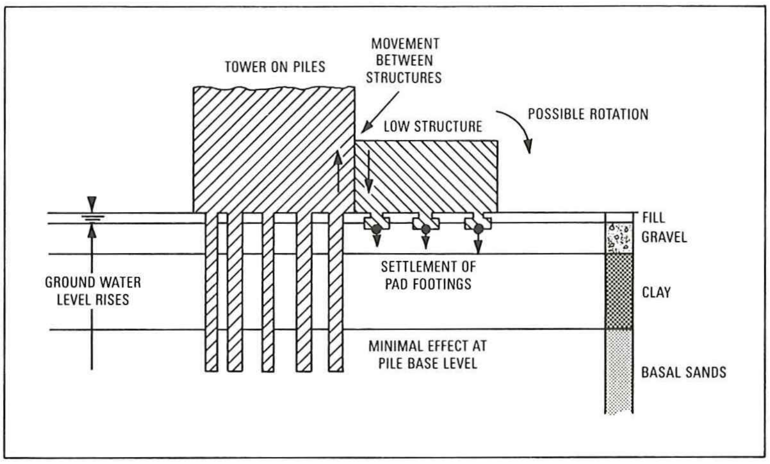


Figure 7—Differential settlement in granular soil

(*d*) *Chemical Attack* The rising groundwater may itself contain naturally-occurring chemicals, notably sulphates from Basal Sands, which could attack concrete especially where sulphate-resisting cement had not been used in the first instance.

STRUCTURAL ASSESSMENT

In assessing if a particular structure is likely to be at risk of loss of stability or serviceability, three basic variables need to be taken into account:

(*a*) *Time Dependency* As has been stated, the rate of rise in different parts of London will be different. In some cases, the rate of rise will be such that the structure will have reached the end of its useful life before any effects become apparent.

(*b*) *Locality Dependency* The local topography and underlying strata strongly influence whether or not a structure will experience problems.

(*c*) *Structure Dependency* A large number of structures will be tolerant of any effects resulting from rising groundwater regardless of their location. At the other extreme, however, the integrity of some buildings may be placed at hazard.

Each structure in London will need to examined separately in the light of these three variables. In the majority of cases, this will be a simple operation leaving a minority to be subjected to a more detailed review. In some cases, it will be necessary to monitor performance, and undertake preventative or remedial work.

The full research report[1] includes a series of maps which enables structure owners to pinpoint potential problem sites and gives guidance to assist in assessing which types of structure are likely to be at risk.

POSSIBLE FUTURE ACTIONS

As the problem of rising groundwater in London is the by-product of human activity, it is also possible to control or reverse the trend. The options identified in the study are:

- Do nothing, and let the water rise and deal with problems if or when they occur. This could be an expensive option as the foundations of all new buildings in affected areas will have to be designed on the assumption of a change in groundwater conditions.
- Zonal control, which would treat central London as a zone and control the general water level by pumping.
- Local control, leaving individual building owners to control locally the water level by pumping.

The second option is by far the most effective and economic solution, but the question of who should take the long-term responsibility for this has still to be answered.

CONCLUSIONS

The study into rising groundwater in the deep aquifer below London has been important for the zone, but has also served to exemplify the importance of the behaviour of water levels in major urban centres and the potential costs which could be incurred if no action were to be taken to control levels. In the case of London, a number of years will elapse before the water level begins to affect BT property. The deep level cable tunnels will be affected first, but it seems likely that there will be no serious effects. The effects on buildings have still to be assessed and this could be a complex process for some buildings. It is intended that BT will continue to participate in further research both for the London situation and for other cities in view of the large amount of BT's assets which are either underground or which rely on the ground for support.

ACKNOWLEDGEMENTS

The author acknowledges the permission of the General Manager, Network Systems Engineering and Technology Department to publish this article and the Director General of the Construction Industry Research and Information Association for the use of data on which the figures have been based.

Reference

1 SIMPSON, B., BLOWER, T., CRAIG, R. N., and WILKINSON, W. B. The Engineering Implications of Rising Groundwater Levels in the Deep Aquifer Beneath London. CIRIA Special Publication 69, London, 1989.

Biography

Don Clow started with the telecommunications side of the British Post Office, now British Telecom, in 1948. For many years, his specialism was design and consultancy work for radio masts, towers and satellite communications antennas. He then 'went to ground' and now leads a section in BTUK head office dealing with the civil engineering aspects of BT's underground cable network. He is chairman of the Executive Committee of the National Joint Utilities Group, and joint-chairman of the Highway Authorities and Utilities Committee. In a personal capacity, he is a member of the Government's Street Works Advisory Committee. He is a Chartered Engineer in both civil and mechanical engineering.

The Federation of the Telecommunications Engineers of the European Community

28th European Telecommunications Congress, Lisbon, Portugal, September 1989

This year's annual FITCE Congress was held in Lisbon, Portugal, from 3–9 September, and attracted over 600 delegates and guests. The venue for the Congress was the splendid halls of the Calouste Gulbenkian Foundation which provided excellent facilities for the work of the Congress.

The focus for debate, 'European Telecommunications—Facing up to 1992', generated 30 technical presentations from all the participating countries. The theme clearly enabled a wide range of interesting and informative papers to be prepared covering such topics as 'A European Telephone Network for Maintenance and Management Communications', 'Impact of SDH on Public Telephone Networks' and 'The European Submarine Cable Network'.

Yet again, a strong team from the IBTE supported the Congress. Three papers were presented by Keith Morgan, Graham Neilson and Neil Runciman on 'Commercial Opportunities in Serving Major Customers', 'Centralised Exchange Management Using Gateway Products', and 'A Common Integrated Database, The Key to Improved Customer Service', respectively. Each year, at the end of the Congress, a prize is awarded by the President of FITCE to the presenter of the best paper. For the second time in three years, an IBTE representative was judged the winner. All our congratulations go to Graham Neilson in achieving this European honour.

The technical programme was concluded with a round-table debate at which leading figures in the European telecommunications field presented their views for open debate. Participants included Fernando Mendes, of the Portuguese Communications Institute, Herbert Ungerer of the European Commission, Norbert Bininda of Siemans and Colin Shurrock, British

Graham Neilson delivering his award-winning paper

Organisation and Operations II session; Neil Runciman, BT, second from right

Left to right: Herbert Ungerer, Rene Kinsoen, Belmiro de Azevedo, Fernando Mendes, Colin Shurrock, and Norbert Bininda

Round table discussion team

Keith Morgan—'Commercial Opportunities in Serving Major Customers'

Telecom Director of Special Studies and Chairman of the IBTE. The speeches on the subject of customers, networks and the Single European Act were both direct and controversial, stimulating considerable debate with the audience.

A varied programme of technical visits had also been prepared by the hosts including manufacturing plants and network operations of the Portuguese network administration. The visits together with Portuguese cultural events in the evenings provided a full and entertaining programme, which helped to foster friendly relations between the telecommunications engineers from the member countries.

This was the first occasion on which Portugal had hosted the Congress and was a resounding success fully justifying the support of the record audience. After a tiring week, the IBTE party were of the common view that it had been a good Congress, setting high standards for IBTE's efforts in Glasgow in 1990.

R. A. WARD
Chairman, IBTE Lancs and Cumbria Centre

29th European Telecommunications Congress, Glasgow, 1990

Over 350 FITCE members from other EEC countries are expected to come to Glasgow, from 27 August to 1 September 1990, to join UK members for the 29th technical Congress. The Congress has been an annual event since 1962, when the first one took place in Luxemburg, and is now coming to the UK for the first time.

The Congress will be held in the Forum Hotel, Glasgow. This new conference hotel, which opened this summer, is positioned adjoining the Scottish Exhibition Centre, overlooking the river Clyde. It has fast and easy access to Glasgow Airport, the M8 motorway and main-line railway stations, and to the city's commercial and shopping centre.

Technical discussions will be centred on around 30 papers, with the theme likely to be 'Developing Telecommunications Networks towards the year 2000, to meet the National and Global needs of European Customers, specifically in the fields of:

- Customer Services,
- Operational Management Systems, and
- Network Architecture'.

Throughout the Congress, simultaneous interpretation will be available between English, French and German.

A range of half-day excursion visits is being arranged to manufacturing premises and major telecommunications operational sites in central Scotland.

Many of the delegates are expected to bring their wives (or husbands) to the Congress, and a day programme is being arranged to take these guests to see some of the Scottish attractions within easy travelling distance of Glasgow.

After the working sessions, a varied and entertaining programme of social events will take place to complement the formal programme. It is expected that this will include:

Civic reception, in the Glasgow City Chambers.
Visit to the Burrell Collection.
Full-day outing for delegates and accompanying persons.
Scottish Opera performance of *Tosca*, in the Theatre Royal, Glasgow.
Dinner/dance, at Hopetoun House, West Lothian.

As Glasgow has been selected as European City of Culture for 1990, and the Congress is being held at a peak tourist time, coincident with the Edinburgh International Fetival, hotel accommodation in Glasgow city centre will be very heavily booked at the time of the Congress. Block reservations have, however, been made at a number of leading hotels in the city, at specially negotiated rates, to ensure that a sufficient supply of good quality hotel accommodation will be available for Congress delegates.

A. B. WHERRY
Chairman, FITCE Congress Organising Committee

THE INSTITUTION OF BRITISH TELECOMMUNICATIONS ENGINEERS

(Founded as the Institution of Post Office Electrical Engineers in 1906)

General Secretary: Mr. J. H. Inchley, NPW9.3.1, 4th Floor, 84–89 Wood Street, London EC2V 7HL; Telephone: 01–250 9816.
Membership and other enquiries should be directed to the appropriate Local-Centre Secretary as listed on p. 188 of this issue of the *Journal*.

NEW IBTE CHAIRMAN

The new Chairman of the IBTE Council is Colin Shurrock, Director Special Studies.

Colin joined the British Post Office in 1962 as an Executive Engineer, after five years as a student apprentice with GEC. He spent the early years of his career engaged in the development of TXE3/4, the production and control of the exchange equipment investment programme, and network strategy. In June 1982, he was appointed Regional Director of South East Region until national reorganisation in 1984. He then returned to Local Communications Services Headquarters as Director of Business Strategy with responsibility for the Local Network Strategy Task Force and the development of the business strategy process for the new Districts. In 1985, he was appointed to Corporate Strategy Department to carry out a fundamental review of the UK's network business, and, as Director of Systems Strategy, he remained in this role until December 1988. As Director Special Studies, Colin transferred to BTUK in January 1989 to carry out a review of the London network business and to assist in the creation of an appropriate development plan.

Colin is Chairman of the British Institute of Management South East Regional Board, and non-executive member of Fulcrum (a British Telecom subsidiary) Board.

Colin Shurrock took over as Chairman of the IBTE Council in May this year, from John Tippler, then Director Network, BTUK, who had been Chairman since 1987.

John Tippler was born in August 1929 and joined the GPO in 1947. After experience of working in a telephone area he moved to the Engineering Central Training School at Stone in 1954 and did much of the training groundwork for the early ventures in electronic telephone exchanges. He has been a champion of engineering education ever since. In 1959, he moved to the Engineering Department in London and continued his long association with the development of electronic switching, being associated with much of the early pioneering work, including TXE4 and System X. He became Director of Exchange Systems in 1980. Although an acknowledged expert in switching, he is particularly interested and knowledgeable about its history. More recently, as Director Network, he played the major role in modernising BT's network.

Always a champion of the interests of IBTE, John has contributed to the *Journal* and lectured to many Local Centres. From 1983 to 1987 he was Chairman of the Associate Section and then Chairman of the Editorial Board and IBTE Council.

Colin Shurrock, Chairman of Council

John Tippler, former Chairman of Council

A. B. WHERRY—SPECIAL AWARD

The IBTE has made a Special Award of a commemorative medal and scroll to Brian Wherry, on his retirement, to give specific recognition to his long and effective contribution to the development and running of the Institution during a period of significant change in the telecommunications industry.

With his service spanning a period of over 25 years, and with his considerable energies devoted to supporting and fostering the IBTE, Brian has become almost an institution within the Institution.

During his periods of office, he has progressed from being an Executive Engineer engaged on network planning in the Engineer-in-Chief's Office of the Post Office Telecommunications Headquarters to holding the position of Director, British Telecom Scotland and Northern Ireland, and subsequently was appointed Chairman of the new Scottish Business Advisory Forum.

His list of offices in the Institution makes impressive reading. He started his service as London Honorary Centre Secretary, an office he held for the four years from 1962 to 1966. Then followed a long period of 12 years until 1978 as Institution Secretary, at the conclusion of which he was created an Honorary Member of the Institution.

For the nine years from 1980 until his retirement in 1989, Brian was Vice-Chairman of Council and Member of the *Comité de Direction* of the Federation of the Telecommunications Engineers of the European Community (FITCE).

The President of the Institution, Clive Foxell, presented the Special Award to Brian Wherry on 12 September 1989 as a measure of IBTE's debt of gratitude for his unparalleled record of service and commitment. He also, on behalf of all of its members, wished Brian a long and happy retirement.

Clive Foxell (left), IBTE President, presenting Brian Wherry with an Institution Scroll and Medal

LOCAL AWARD—NORTH WALES AND MARCHES CENTRE

The Committee of the North Wales and the Marches Local Centre has granted an award for the best lecture by a Local-Centre Member during the 1988–89 programme session. On 13 June 1989, the Local-Centre Chairman Glynne Hughes presented Bill Jones, Shrewsbury Computer Centre Network Manager, with an Institution Scroll and a cheque for £25.

Glynne Hughes (left), Chairman, North Wales and Marches Centre, presenting Institution Scroll to Bill Jones

The award was in recognition of a presentation given by Mr. Jones in February 1989 entitled 'District Data Networks'. The lecture reviewed the development of data transmission and demonstrated that the considerable numbers and variations of existing terminals, hardware and software systems and networks had led to inefficiency and incompatibility. The solution was to introduce a new network called *Internet*, based on international standards and using purpose-designed terminals. The network and its component parts were described with the aid of computer-derived graphics projected onto a large screen.

IBTE LOCAL-CENTRE PROGRAMMES 1989–90

Aberdeen Centre

Meetings will be held in CCC, 9 Bridge Street, Aberdeen, commencing at 14.00 hours.

5 December 1989: *Interconnect Mercury* by D. Peacock.

9 January 1990: *CSS—What's New?* by P. Green.

6 February 1990: *The Future of the Socket on the Wall* by F. J. DeLapeyre.

East Anglia Centre

17 January 1990: *The Bishop's Stortford Trial* by G. Taylor, Network Systems Engineering and Technology, BTUK. To be held at 3rd Floor Conference Room, St. Peter's House, Colchester, 12.30–14.30 hours. Buffet lunch provided.

7 February 1990: *Consideration in the Provision and Management of Private Networks and Systems for the Credit Card Industry* by R. Meggs, Manager, Telecom Support, Access. To be held at Charter Suite, Civic Centre, Victoria Avenue, Southend-on-Sea, 14.00–16.00 hours.

14 March 1990: Three short papers by Members. To be held at 3rd Floor Conference Room, St. Peter's House, Colchester, 12.30–14.30 hours. Buffet provided.

16 May 1990: *The BT Scene as viewed by AT&T & Philips* by J. Boag, AT&T & Philips Telecommunications. To be held at 3rd Floor Conference Room, St Peter's House, Colchester, 12.30–14.30 hours. Buffet lunch provided.

11 July 1990: *The Challenge of the 90s* by L. Stannage, Field Director, Central and South West England and Wales Territory. To be held at The Council Chamber, The Guildhall, Cambridge, 14.00–16.00 hours.

East Midlands Centre

All meetings will commence at 14.00 hours.

6 December 1989: *Network Restructuring* by K. Sandum, Network Planning and Works, BTUK, and J. Waddy, East Midlands District, BTUK. To be held at T1 Lecture Theatre, Nottingham University.

10 January 1990: *What is my Role in 1992* by Miss Marion McCrindle, Deputy Head, European Office. To be held at Leicester University.

14 February 1990: *A Glimpse of the Future* by Dr. T. Rowbotham, Director Network Technology, British Telecom Research Laboratories. To be held at Nottingham University.

14 March 1990: *Optical Fibre in the Local Network* by K. Oakley, Network Systems Engineering and Technology, BTUK. To be held at Peterborough Ex-Servicemen's Club.

London Centre

9 December 1989: Family Christmas Lecture *The Sky's the Limit* by Heather Couper, Authoress and Broadcaster. To be held at The Institution of Electrical Engineers, Savoy Place, London WC2. Morning and afternoon sessions. Tickets from Local-Centre Secretary.

25 January 1990: *Towards a Global ISDN* by P. Walker, Director Planning, British Telecom International. To be held at Assembly Rooms, Fleet Building, 40 Shoe Lane, London EC4. Buffet at 12.30 hours; lecture at 12.45 hours.

30/31 January/1 February 1990: Faraday Lecture, *Electric Currency* by Bank of Scotland. Barbican Hall, Barbican Centre, London EC2. Tickets: The Faraday Officer, IEE, Michael Faraday House, Six Hills Way, Stevenage, Herts SG1 2AY.

Manchester Centre

Lectures will be held at UMIST, Manchester, commencing at 14.00 hours.

29 November 1989: *Network Architecture*, a joint IBTE/FITCE seminar. European and British speakers.

10 January 1990: *Exact System Specification—Is it an Impossibility?* by Dr. D. Leakey, British Telecom Chief Scientist.

14 February 1990: *The Rise and Fall of Digital Transmission (and Switching)* by Dr. P. Cochrane, Networks Division, British Telcom Research and Technology.

Martlesham Heath Centre

Meetings will be held in the John Bray Lecture Theatre, British Telecom Research Laboratories, Martlesham Heath, commencing at 16.00 hours.

28 November 1989: *The Sizewell B Project* by W. Charlesworth, Sizewell Management Team, CEGB.

13 December 1989: *Poster Day.* A special event for recent recruits, BTRL.

10 January 1990: *Intelligent Networks* by D. Millington, British Telecom Research and Technology.

26 January 1990: *CSD: Current Aims and Future Opportunities* by D. Dey, Managing Director, British Telecom Communications Systems Division. Lecture open only to BT employees; entry will be by ticket only (available from Martlesham Heath Centre Secretary).

14 February 1990: *The Competitive Environment* by J. C. Hibbert, DFA, British Telecom Research Laboratories. Lecture open only to BT employees; entry will be by ticket only (available from Martlesham Heath Centre Secretary).

7 March 1990: *Advances in Superconductivity* by Dr. A. Campbell, University of Cambridge.

27 March 1990: *Engineering in IAL's World of Aviation and Health Care* by A. Martin, General Manager, International Aeradio Ltd.

North Downs and Weald Centre

Except where stated, meetings will be held in the Stour Centre, Ashford, 14.00–16.00 hours. Refreshments from 13.30 hours.

13 December 1989: *Channel Tunnel* by A. Gueterbock.

17 January 1989: Visit to Dover Coast Guards.

14 February 1990: *Total Quality Management* by IBM, Havant.

14 March 1990: *Local Loop* by R. McLachlan, BTUK.

North Wales and the Marches Centre

All meetings will commence at 14.00 hours.

29 November 1989: *The Rise and Fall of Digital Transmission* by Dr. P. Cochrane, Optical Networks Division, British Telecom Research Laboratories. Combined meeting with South Wales Centre. Beauchamp Hotel, Shrewsbury.

9 January 1990: *Radio Navigation for Ships and Aircraft* by Dr. J. D. Last, University College of North Wales, Bangor. To be held at Queen Hotel, Chester.

20 February 1990: *Links Around the World* by A. J. Booth, Managing Director, British Telecom International. To be held at Whittington House, Oswestry.

6 March 1990: *Local Network Recovery Programme* by A. Ingram, Central, South West England and Wales Territory. To be held at Beauchamp Hotel, Shrewsbury.

Northern Ireland Centre

All meetings will be held at BTNI, Business Centre, Dial House, Belfast, commencing at 15.30 hours.

6 December 1989: *Total Quality Management in the Aircraft Industry* by W. Morris, Quality Manager, Short Bros. plc.

10 January 1990: *A Glimpse of the Future* by Dr. T. Rowbotham, Director Network Technology, British Telecom Research Laboratories.

7 February 1990: *The Use of Computers in Maintenance* by H. Topping, and J. Porter, British Telecom Northern Ireland.

7 March 1990: *Customer Billing in the Modernised Network* by M. Kennedy, British Telecom Northern Ireland.

Severnside Centre

7 February 1990: *Electronic Messaging and Value-Added Services* by C. Jones, Dialcom Europe Ltd. To be held at Mercury House, Bristol, 14.15 hours.

8 March 1990: *Network Administration, Its Evolution Towards the 1990s* by A. Bealby, General Manager, Network Operations Support, BTUK. Joint meeting with Associate Section. To be held at Watershed, Bristol, 14.15 hours.

4 April 1990: *The President's Lecture* by A. Hurley, District General Manager, Severnside District, and Chairman, IBTE Severnside Centre. To be held at Nova House, Bristol, 14.15 hours.

South Downs Centre

Meetings will be held in the Lecture Theatre, Central Library, Richmond Road, Worthing, commencing at 12 noon.

12 December 1989: *Mercury Interconnect in the South East* by A. Sharp, Interconnect Liaison Manager, Thameswey District, and M. Elliott, Regional Interconnect Co-ordinating Manager.

9 January 1990: Two lectures: *And then there was Light!* by R. Grindley, Local Network Digital Access Manager, South Downs District. *South Downs Central Records Maintenance Office* by M. Jolliffe, Central Records Maintenance Office Manager, South Downs District.

13 February 1990: *The South East Network Operations Unit* by P. Stables (SE NOU Project Manager).

13 March 1990: *A Glimpse of the Future* by Dr. T. Rowbotham, Director, Network Technology, British Telecom Research Laboratories.

West Midlands (South) Centre

6 December 1989: *United States Air Force* by R. Colley, RAF Upper Heyford. Joint senior/Associate Sections (Coventry/Birmingham). To be held at BT Sports and Social Club, 1st Floor, Regency House, Queens Road, Coventry, 19.15 hours. Free buffet.

West Midlands (North) Centre

Meetings will be held at British Telecom Technical College, Stone.

11 December 1989: *Linking Design and Testing—The Pitfalls and the Benefits* by D. Hannah, Marconi Instruments. Combined IEE/IBTE meeting. Refreshments at 17.30 hours, lecture at 18.15 hours.

8 January 1990: *FITCE—A New Member's View* by D. Corrie, Training Department, BTUK. Meeting will commence at 13.45 hours.

19 February 1990: *Telecommunications in Sweden* by D. Podmore, Training Department, BTUK. Meeting will commence at 13.45 hours.

IBTE CENTRAL LIBRARY

The books listed below have been added to the IBTE Library. Copies of the 1982 edition of the library catalogue are available from the Librarian, IBTE, Room GJ, 2–12 Gresham Street, London EC2V 7AG. An abbreviated catalogue is included with this issue of the *Journal*. Library requisition forms are available from the Librarian, from Local-Centre and Associate Section Secretaries and representatives. The forms should be sent to the Librarian. A self-addressed label must be enclosed.

The IBTE Library is open on Wednesday mornings between 11.00 and 13.30. Members are advised to telephone the Librarian (01–356 8050) to confirm their visit. Members wishing to reserve books or check availability should contact the Library during opening times on 01–356 7919.

The Library is open to Full, Associate Section and retired Members of the IBTE.

5468 *Handbook of Effective Technical Communications* by T. G. Hicks, and C. M. Valorie.

Many people from time to time throughout their careers become involved in report and specification writing, whether it be on one side of a piece of A4 or a mini book, for some even a book. This comprehensive publication covers all aspects giving clear guidelines, advice and markers for pitfalls. There is even a section on letter writing which most of us could do well to take notice of. It can be easily read from cover to cover or, and possibly where it may be of greater value, used as a reference.

5469 *Mastering Documentation—With Document Masters for Systems Development, Control and Delivery* by Paula Bell and Charlotte Evans.

The production and maintenance of software documentation is a task which is all too often neglected but, as a vital part of the overall product, it merits considerably more attention than it is usually given. This book is obviously the product of considerable experience in the field of software project management along with the production of supporting documentation and literature, and is firmly linked to a practical approach.

The book deals with the entire life cycle of software production and delivery. In the first of five sections, it explains in clear terms the use of documentation at all stages from specification through to system delivery. It examines this from different perspectives—from project manager, developer and writer to end user—and contains much common sense advice and warnings of pitfalls to guide the reader.

The second section introduces the concept, carried out through the rest of the book, of document masters which lead the reader through all the requirements for providing the functional, performance and resource support specifications for a system.

Section 3, on project control, provides the masters for organisation management plans and tracking procedures. Section 4 deals with system development and covers architecture, prototype and detailed design documentation, in addition to test specification and test report masters. The final section is devoted to system delivery and covers the production of the user guide, release description, system administrators guide and the acceptance sign-off.

Although not a book for the absolute beginner, it is very straightforward. Its technique of providing a path through extensive document masters should provide all the necessary prompts to ensure a consistently thorough set of systems documents. Users of other project management documentation, such as PROMPT II or TELSTAR, will find that the masters in this book are not instantly adaptable, but there is still sufficient good advice and practical guidance given to make this book well worth reading.

RETIRED MEMBERS

Members about to retire can secure life membership of the Institution at a once-and-for-all cost of £10·00 and so continue to enjoy the facilities provided, including a free copy of the *Journal*. Enquires should be directed to the appropriate Local-Centre Secretary.

NOTIFICATION OF CHANGES OF ADDRESS

IBTE Members and *Journal* subscribers who change their home address should ensure that they notify the *Journal* office on the address-label slip provided with every copy of the *Journal*.

All enquiries related to distribution of the *Journal* should be directed to The IBTE Administration Manager, 3rd Floor, 84–89 Wood Street, London EC2V 7HL. (Telephone: 01–356 8050.)

LOCAL-CENTRE SECRETARIES

The following is a list of Local-Centre Secretaries, to whom enquiries about the Institution should be addressed.

Centre	*Local Secretary*	*Address and Telephone Number*
Aberdeen	Mr. A. T. Mutch	British Telecom, D2.1.6, New Telecom House, 73–77 College Street, Aberdeen AB9 1AR. Tel: (0224) 753343.
East Anglia	Mr. T. W. Birdseye	East Anglia District LN1.5.12, Telephone House, 45 Victoria Avenue, Southend-on-Sea, Essex SS2 6BA. Tel: (0702) 373106.
East Midlands	Mr. D. H. Bostrom.	IO4, 200 Charles Street, Leicester LE1 1BA. Tel: (0533) 534212
East of Scotland	Mr. B. Currie	British Telecom East of Scotland District, NJ3, Telephone House, 357 Gorgie Road, Edinburgh EH11 2RP. Tel: 031–345 4218.
Lancs and Cumbria	Mr. A. J. Oxley	SM4, BMC, North Street, Preston PR1 1BA. Tel: 0772 265419.
Liverpool	Mr. B. Stewart	British Telecom Liverpool District, CS63, Room 413, Lancaster House, Old Hall Street, Liverpool L3 9PY. Tel: 051–229 4444.
London	Mr. C. J. Webb	British Telecom, LSO/PA1.6.4, Room 1105C, Camelford House, 87 Albert Embankment, London SE1 7TS. Tel: 01–587 8258.
Manchester	Mr. J. M. Asquith	British Telecom, NE20, Telecom House, 91 London Road, Manchester M60 1HQ. Tel: 061–600 5171.
Martlesham Heath	Mr. M. Shaw	RT5241, MLB/3/50, British Telecom Research Laboratories, Martlesham Heath, Ipswich IP5 7RE. Tel: (0473) 645594.
North Downs and Weald	Mr. N. Smith	British Telecom, NP4, Telephone House, Rheims Way, Canterbury, Kent CT1 3BA. Tel: (0227) 474594.
North East	Mr. P. L. Barrett	British Telecom North East, EP38, Swan House, 157 Pilgrim Street, Newcastle-upon-Tyne NE1 1BA. Tel: 091–261 3178.
North Wales and the Marches	Mr. P. C. Clay	N5.4.3, Communication House, Harlescott Lane, Shrewsbury SY1 3AQ. Tel: (0743) 274353.
Northern Ireland	Mr. B. Hume	EI4, RAC House, 79 Chichester Street, Belfast BT1 4JE. Tel: (0232) 327152.
Severnside	Mr. P. Lewis	RM 45, Mercury House, Bond Street, Bristol BS1 3TD. Tel: (0272) 252879.
Solent	Mr. D. Henshall	BE33, Solent District Office, 70–75 High Street, Southampton SO9 1BB. Tel: (0703) 823421.
South Downs	Mr. C. J. Mayhew	British Telecom South Downs District Office, ED8, Grenville House, 52 Churchill Square, Brighton, BN1 2ER. Tel: (0273) 225030.
South Midlands	Mr. J. Coley	British Telcom, LL144, Telecom House, 25–27 St. Johns Street, Bedford MK42 0BA. Tel: (0234) 274849.
South Wales	Mr. P. F. Coleman	NP3, British Telecom South Wales, District Engineering Office, 25 Pendywallt Road, Coryton, Cardiff. Tel: (0222) 691622.
Thameswey	Mr. R. D. Hooker	Thameswey District Head Office, DE4.4, Telecom House, 49 Friar Street, Reading, Berkshire RG1 1BA. Tel: (0734) 501754.
West Midlands (North)	Mr. R. J. Piper	c/o Mr. M. N. B. Thompson, BT Technical College, Stone, Staffordshire ST15 0NL. Tel: (0785) 813483.
West Midlands (South)	Mr. G. R. Chattaway	British Telecom, BE3.8, Telecom Centre, The Butts, Coventry CV1 3TH. Tel: (0203) 228396.
West of Scotland	Mr. L. M. Shand	TNO/S1.4.4, Dial House, Bishop Street, Glasgow G3 8UE. Tel: 041–221 1585.
Westward	Mr. R. Rand	British Telecom, NP2, Exbridge House, Commercial Road, Exeter EX2 4BB. Tel: (0392) 212681.
Yorkshire and Lincolnshire	Mr. R. S. Kirby	BTUK/North/NO3, Netel House, 6 Grace Street, Leeds LS1 1EA. Tel: (0532) 466366.

ASSOCIATE SECTION INTER-DISTRICT COMMITTEE CONTACT POINTS

The following is a list of Associate Section Inter-District Committee contact points to whom enquiries about the Associate Section should be addressed.

Inter-District Committee	*Contact*	*Telephone Number*
East	Mr. T. Turner	(0345) 333111
London	Mr. J. Tythe	01–804 2400 Extn. 352
London Postal	Mr. M. E. Candy	01–250 2916
Midlands	Mr. J. Sanson	(0604) 35999
North East	Mr. K. Whalley	(0642) 310937
North West	Mr. R. Craig	(0772) 267236
Northern Ireland	Mr. R. Gamble	(0232) 667307
Scotland	Mr. C. D. Ritchie	(0224) 584206
South East	Mr. M. Harvey	(0424) 435437
South West	Mr. J. R. Dymott	(0202) 206497
Wales	Mr. F. Brown	(0592) 49886

British Telecom Press Notices

Video Communications for the Deaf

A unique system of moving cartoon pictures on miniature television screens which could allow deaf people to communicate over the ordinary telephone network using sign language has been developed by British Telecom.

This experimental equipment, developed by scientists at the company's research laboratories at Martlesham Heath, near Ipswich, in collaboration with the University of Essex, has been tested by the Suffolk Deaf Association. It has allowed Pearl Kerridge, the social worker attached to the Association's headquarters in Ipswich, to have frequent 'conversations' with two of the members, Jack and Linda Kirk, at their home on the outskirts of the town.

Commenting on the project, Dr Tom Rowbotham, Director of Network Technology at British Telecom Research Laboratories, said: 'Once again British Telecom is making telecommunications history. We believe that this development enabling deaf people to sign to each other over the telephone network is the first of its kind anywhere in the world. It is a very fruitful outcome of innovative collaboration between the laboratories and the University of Essex—a truly unique combination of hardware and software developed as part of British Telecom's activities aimed at meeting the needs of disabled people.'

The equipment used in the trial is based on the experimental videophone developed at BT's laboratories. This is a desk-top unit containing a miniature video camera and 6 cm square (2·5 inch) television screen. When used for its original purpose, the videophone can give each person in a telephone conversation a moving colour head-and-shoulders picture of the other. But it will work only over a digital system. Its picture content, although greatly reduced from that of broadcast television, is still too high to be sent over an analogue telephone network using a single line. To make the equipment operate over an ordinary telephone link, the Research Laboratories applied the results of work on picture compression carried out under a contract placed by them with the University of Essex.

The image-coding algorithms developed by Professor Don Pearson at Essex reduced the picture content to a level enabling its information to be sent over BT's analogue network at 14 400 bit/s. The resulting picture is a moving black-and-white outline, or cartoon. It depicts the main facial characteristics sufficiently for the individual to be clearly recognised. And it also enables the hand movements or sign language to be reliably identified.

The trial involving Ms Kerridge and Mr and Mrs Kirk was set up by the laboratories in February to demonstrate the technical feasibility of the system, and was supported by BT's Action for Disabled Customers unit.

The next stage now being planned is a larger-scale trial involving up to 50 participants. This would provide a much wider range of user experience, enabling a basic terminal design to be developed.

Dr Rowbotham added: 'I am particularly grateful to Ms Kerridge and Mr and Mrs Kirk of the Suffolk Deaf Association. Their co-operation has been of great value in enabling us to demonstrate successfully the technical feasibility of the system. In the UK, about a quarter of a million people suffer from hearing loss which makes it very difficult or impossible for them to use the telephone for speech communication, and about 50 000 people use sign language. Our development opens up the prospect of breaking down the telephone barrier, enabling them to converse by telephone using the alternative medium of sign language.

'But a commercial product is still many years away. A lot more research and development has still to be undertaken. And we will need to explore the possibility of markets overseas, to develop a critical mass for a product whose cost could benefit from economies of scale'.

Major Unleaded Initiative by British Telecom

British Telecom's entire fleet of 66 000 vehicles—the biggest in Europe—will run completely free of lead by 1991, making a significant contribution to the protection of the environment.

Research by a special BT project team has paid off with a permanent and inexpensive method of converting the cylinder heads of petrol-driven vans. This method involves machining out the old valve seats and replacing them with new hardened versions. As a result, the company can convert its entire fleet at an acceptable cost.

Conversion work, which is expected to be completed by March 1991, is the latest move in plans to make BT's vehicle fleet environment-friendly. Since the spring, the company has insisted on all its new petrol-driven vehicles being capable of running on unleaded fuel. There has also been a move towards using more diesel-driven vehicles, which now number more than 14 000.

Of the 52 000 petrol-engined vans run by BT at the end of March, only 3300 could operate on unleaded petrol. Some 13 000 are due for replacement this year, which would have left 35 000 vans not capable of running on unleaded petrol because they do not have hardened valve seats in the engines. The vehicles involved are mainly Ford, Freight Rover and Austin Rover in the 500 kg, 750 kg, and 1 tonne payload sizes. BT considered early replacement of these vehicles but decided that a more positive contribution to the environment would be to fit existing vehicles with hardened valve seats. Manufacturers Ford, Leyland Daf and the Rover Group provided invaluable support for the BT team, in particular the Rover Group in the testing work they carried out on the new valve seats under stringent conditions.

Cost of the conversion campaign will be about £3·2M, but there will be an annual saving on fuel costs of about £2M at current prices. A specially trained team will carry out the conversions, which will be carried out on a District-by-District basis.

Message Handling Systems Testing for European Open Systems

British Telecom is to play a major role in the recently-launched Open Systems Testing Consortium (OSTC) to assist and promote the growth of open systems which allow otherwise incompatible computing installations to communicate with each other.

The British Telecom Eurolab at Ipswich is now offering approved testing for message handling systems (MHSs). The main users of this service will be developers, suppliers and procurers of MHS products. The testing is performed remotely over the public data network, enabling products to be tested anywhere in the world.

The OSTC comprises European public network operators, commercial organisations and research establisments. It has set up test laboratories in Europe to ensure that Open Systems Interconnection (OSI) testing of computer communications equipment is consistent throughout the Continent. Such consistency is regarded as essential in paving the way towards the wider implementation of the growing international standard of OSI.

BT is a founder member of the OSTC, and its Eurolab is one of the conformance testing laboratories. Reports issued by any of the test laboratories will be recognised and accepted throughout Europe. This will lead to reduction in the cost of testing because manufactures or suppliers will need to have their equipment tested only once, in one country, rather than have to get it tested in each individual country in which it could be used.

If a product or service is approved by the OSTC, it will be given a mark, in the same way that the British Standards Institution's 'Kitemark' works. This will assure users that the product or service has been tested by the OSTC validated laboratory.

Book Reviews

Measurement of Software Control and Assurance

B. Kitchenum and B. Littlewood.
Elsevier Applied Science Publishers Ltd. xiii + 392 pp. 87 ills. £55·00.
ISBN 1–85166–246–4.

This book attempts to present the latest research results of the European metrics community for consumption by fellow researchers and perhaps even some practitioners. As the editors write in the preface: 'Many...believe that quantitative approaches are now mature enough to be more widely used'. The European metrics community has indeed received a boost in recent years from various collaborative programmes, in particular Alvey and Esprit, and many fascinating approaches to the measurement and modelling of software processes and products are now emerging. While this collection of papers, provides a useful reference for the researcher and consultant in the field, overall it comes over as rather heavy reading for the practitioner. There are, however, some gems for the interested project manager or software engineer.

Darrel Ince provides a very readable and comprehensive overview of the field. We agree with Darrel's general approach which is captured in the following phrase from his tutorial, 'System metrics measure large-scale properties of a system, usually the quality of a system design. Potentially, they are the most useful because they can be extracted during an early phase of a project...hence are capable of predicting more'.

'The Collection and Use of Data for Monitoring Software Projects' is an excellent pragmatic guide for those considering serious metrication programmes. It illustrates the power of the graph over the mathematical formula. Similarly, 'Analysis of Software Metrics' is a useful introduction to statistical analysis techniques. It is time that statistics became an essential tool of software engineering.

'The Cleanroom Software Development Process' is a fascinating, and at times incredible, report of the application of statistical quality control to software at IBM. Particularly interesting is the statistical approach adopted to testing. To quote: 'The testing strategy is organised so that the chance of finding a software defect is ordered precisely according to the rate at which the defect will trigger a software failure....the approach uses considerable upfront analysis to define the software usage'.

'New Trends in Cost-Estimation' provides a good overview of the current state of the art and indicates a sensible way forward in this crucial area. The authors' strong endorsement of the case for 'expert system support of analogy-based estimation methods' concurs with our own view and we look forward to learning more about their Esprit project, 'The Integrated Management Process Workbench (IMPW)'.

As researchers ourselves in Quality Metrics, we found 'Quality Requirements Specification And Evaluation' essential reading. Particularly interesting was the authors' observation that certain quality factors invariably pull against each other, while others often pull together. To quote the authors: 'Performance tends to be at odds with most of the other factors, as many of us have found to our cost....If maintainability has been rated as highly significant, then the chances are that the end product will also show a fair degree of extendability and reliability should also be enhanced'.

We can postulate underlying theories about the internal properties of software designs and implementations to account for our external observation of various quality factors. However, there are immense difficulties in formulating and then validating such theories. 'An Engineering Theory of Structure and Measurement' provides insights for those interested in such deep problems.

A. Todd, S. Minnis, and G. Robinson

Expert Systems Introduced

Donal Daly, with Frank Bannister and Jurek Kirakowski.
Chartwell-Bratt Ltd. 192 pp. 2 MS-DOS discs. £15·95.
ISBN 0–86238–185–1

The book attempts to de-mystify the expert system euphoria and aims to introduce the applications of expert systems for commercial use to non-data-processing, non-academic and non-artificial-intelligence researcher PC users.

Naturally, over-simplifications are made in order to limit the scope of the book and to present a practical guide in constructing an expert system on a PC. To this end, the book meets its objectives. Primarily, 'goal driven' rule-based systems are considered and it is claimed that these meet the requirements of 'commercial' expert systems. The scope of these commercial applications is necessarily limited.

The book comprises two equal parts. The first part essentially covers the basic notions of an expert system and gives a survey of available tools, languages on PCs and dedicated computers for developing expert systems. The second part is a tutorial on how to use the expert system shell CRYSTAL to develop a simple application. Two diskettes containing the trial-sized CRYSTAL software accompanies the book.

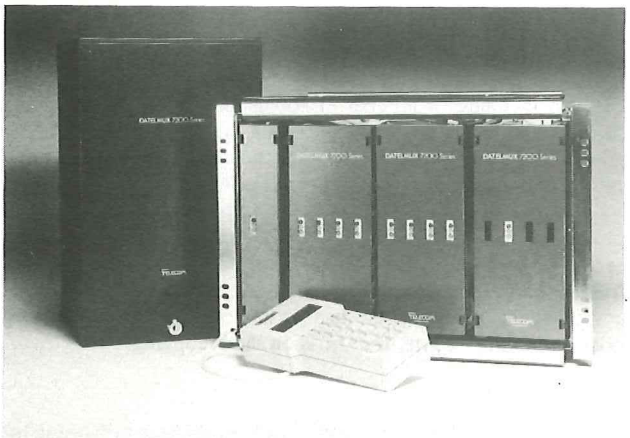
M. Azmoodeh

Product News

British Telecom Launches New Range of TDM MegaStream Multiplexers

In response to companies' growing needs for transmission of voice and data, BT has launched the DM7200 series of digital time-division multiplexers for use over MegaStream services. The new multiplexers will enable users to benefit from the significant operational and cost advantages of running voice and data traffic over a single MegaStream circuit.

The range of voice and data interfaces provide transmission facilities for many applications including high-speed facsimilie, photo videotex, X.400 messaging, desk-top publishing, CAD/CAM, slow-scan TV, videoconferencing, dealing/broking, and digital PBX networking.



Back left to right: Wall-mounted lockable cabinet and standard 19 inch racking options. Front: Menu-driven hand-held service terminal

DM7200 series of digital time-division multiplexers for use over MegaStream services

The DM7200 series supports all networking requirements, with the DM7210 for point-to-point applications and the bidirectional DM7220 for ring, star and drop-and-insert networks. Higher-order applications for 8 Mbit/s, for use with BT's recently launched MegaStream 8 service, 34 Mbit/s and 140 Mbit/s streams are catered for by the DM7230, DM7240, DM7250 multiplexers, respectively. Further applications including X58 multiplexing cards and optical-fibre cards are currently in development.

There is a choice of two network management tools. The first is a menu-driven hand-held service terminal showing the current status of network operation for point-to-point applications and field maintenance. The second, a PC-based system, provides all the management functions needed to maintain the corporate network including network status monitoring and network configuration and control.

The DM7200 has been designed with a number of features to ensure reliable performance. These include low power consumption of 5 W per card; conventional cooling; and change-over units which, in the event of a problem, bypass the affected MegaStream or multiplexer ensuring continuous operation. The quality of engineering and surface mount technology used is reflected in the mean time between failures (MTBF):

7210 multiplex unit (including power supply)	52 years
V.35 5-channel data card	57 years
X.21 5-channel data card	57 years

All the DM7200 modules, including the 10-channel voice module, are contained on 233 mm (9 inch) (H) by 160 mm (6 inch) (D) PCBs. As well as the standard 19 inch racking, the DM7200 series can be fitted in a 5 inch slim rack or wall-mounted lockabale cabinet. All options allow for the system to be extended to incorporate additional features.

New Aid for Visually Handicapped

British Telecom has introduced two new visually handicapped operators' console attachments (VHOCAs) for its successful TSX50 and Monarch telephone switching systems. Developed in close consultation with the Royal National Institute for the Blind (RNIB) and the Association of Visually Handicapped Telephonists (AVHT), the VHOCAs underline BT's proven commitment to meeting the needs of the visually handicapped.

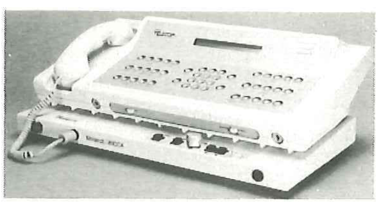
Both VHOCA systems operate using a high-quality voice synthesis module which 'speaks' the console display information to the operator. In this way, visually handicapped operators, prompted by the voice facility, can receive call handling, call status and other helpful prompts and instructions from the console display, and answer and transfer calls with the same ease as fully sighted operators. The Monarch VHOCA also guides the operator through system programming functions, allowing them to make an even fuller contribution to company communications.

The small unobtrusive VHOCA unit is mounted beneath or to the side of the console, and is simply plugged into the Monarch or TSX5O console, which keeps to a minimum the amount of desk space required. The height of the Monarch console may be adjusted to enable the operator to choose the most comfortable working position.

A braille overlay available with the Monarch system and a braille operator guide for the TSX50 are included to assist the operators in accessing the wide range of facilities on each telephone system.

The operator has complete control over the three-speed synthesised voice facility and the volume, which can be channelled through either the integral loudspeech facility on the Monarch system, or through a headset or console handset on both the Monarch and the TSX50.

TSX50 VHOCA



Monarch VHOCA

New Fax Machines from British Telecom

British Telecom has a continuing commitment to providing its customers with competitively-priced sophisticated fax machines. Its range of fax machines is one of the most comprehensive on the market, from the low-cost personal desktop machines, to fully-featured mid-range fax machines and top-of-the-range high-volume models.

New machines recently announced by BT include the CF10, a light and compact fax machine which is ideal for small or home-based businesses and the busy executive who wants a personal desktop fax machine.

It operates at a speed of 9600 bit/s, with automatic fall back and full Group 3/2 compatibility. The CF10 offers an alpha-dial memory which stores 15 numbers under alphabetical keys and enables the user to send after calling a name from the memory. The machine is self-contained—it does not require an external telephone to operate.

The CF10 also offers a 10-sheet automatic document feeder, 50 m paper roll, automatic redialling, a convenient copying feature and a 16 digit liquid crystal display. The choice of standard or fine resolution setting enables the user to send detailed linework.

The time transmission facility, which means the operator can programme the machine to transmit documents automatically at a pre-set time, allows the user to take advantages of cheaper off-peak rates for long distance or overseas calls. Secure transmission is available with the password feature which enables the fax machine to check that the receiver has a matching password, before sending the document.

Polling enables fax users to retrieve documents from remote locations. The convenient voice contact facility allows the sender to speak to the receiver—for example, for confirmation of receipt—while the voice request message facility enables the sender to leave a message after transmission.

The new AD200M fax machine is an enhanced version of the existing AD200 and has a 0·5 Mbyte memory, the equivalent of up to 30 A4 sheets—a facility traditionally only available with high-volume fax machines. The AD200M is a compact and extremely versatile mid-range fax machine, which offers customers not only the added benefit of memory, but also a comprehensive and sophisticated range of features.

Operating at a modem speed of 9600 bit/s, with automatic fall-back, the AD200M is CCITT Group 3/2 compatible and features automatic line-error correction to ensure that every transmission is received clearly, provided that the receiving machine has error correction capability.

Competitively priced, the new machine is designed to maximise the efficiency of a company's business communications and offers a wide range of features including 30 sheet automatic document feed; 16 grey scales, with standard, fine and superfine resolutions; and a local multi-copy function.

The memory can be programmed to route individual documents to a series of different numbers, or by group dialling to up to 100 numbers, automatically.

It also facilitates a number of sophisticated features including one-key dialling to up to 40 locations and abbreviated dialling to up to a further 60 locations; transmission reservation; group polling and turnaround polling, and group broadcast.

The AD200M also features relay transmission and has full networking capability with BT's SF200, AD200 and AD70 fax machines, with the SF200 acting as the 'hub' or relay station. Confidentiality is ensured through password protection and prevention of unauthorised use with software access locking codes, enabling secure transmission and copying.

CF10 fax machine

AD200M fax machine

Notes and Comments

CONTRIBUTIONS TO THE JOURNAL

Contributions of articles to *British Telecommunications Engineering* are always welcome. Anyone who feels that he or she could contribute an article (either short or long) of technical, managerial or general interest to engineers in British Telecom and the Post Office is invited to contact the editors at the address given below. The editors will always be pleased to give advice and try to arrange for help with the preparation of an article if needed.

Guidance for Authors

Some guidance notes are available to authors to help them prepare *Journal* articles in a way that will assist in the uniformity of presentation, simplify the work of the *Journal*'s editors, printers and illustrators, and help ensure that authors' wishes are easily interpreted. Any author preparing an article is invited to write to the Editorial Office, at the address given below, to obtain a copy.

All contributions to the *Journal* must be typed on one side only of each sheet of paper, or they can be submitted on IBM disc. As a guide, there are about 750 words to a page, allowing for illustrations, and the average length of an article is about six pages, although shorter articles are welcome. Contributions should preferably be illustrated with photographs, diagrams or sketches. Each circuit diagram or sketch should be drawn on a separate sheet of paper; neat sketches are all that is required. Photographs should be clear and sharply focused. Prints should preferably be glossy and should be unmounted, any notes or captions being written on a separate sheet of paper. Good colour slides can be accepted for black-and-white reproduction. Negatives are not required.

It is important that approval for publication is given at organisational level 5, and authors should seek approval, through supervising officers if appropriate, before submitting articles.

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'Developing Telecommunications Networks towards the year 2000, to meet the National and Global needs of European Customers'

Specific topics will include:

- The network architecture.
- The structure of the management systems which control network operations and growth.
- The creation of new products and services using the increasing levels of intelligence within the network to meet customers' requirements.

The selected authors will be given the opportunity to present the same papers to an international audience at the 29th European Telecommunications Congress to be held at Glasgow in August 1990.

For further information, please contactTapash Ray, Assistant Secretary FITCE, BTUK/NPW8.1.3, 2C75, The Angel Centre, 403 St Johns Street, London EC1V 4PL. Telephone: 01–239 0429. Fax: 01–239 0426.

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(Founded as the Institution of Post Office Electrical Engineers in 1906)

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